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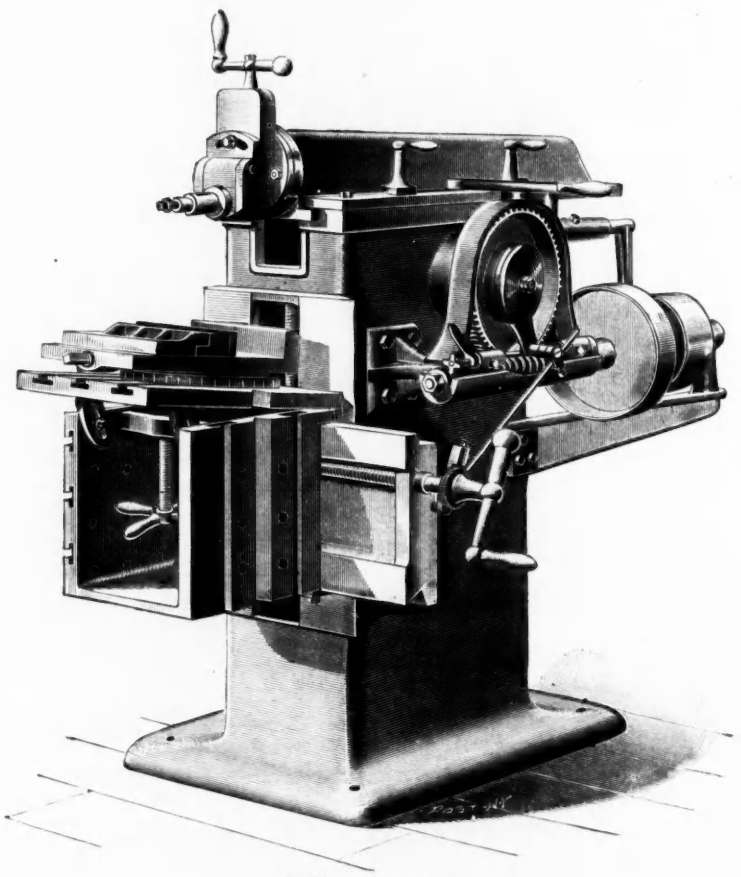
A New Shaper.

The accompanying engraving represents a shaper which in some points is a radical departure from the usual practice in constructing such machines, and consequently possesses some points of interest to the mechanic. The machine is driven by a double friction clutch of simple construction, of which the driving pulleys seen at the right are made to form a part. The conical disks which engage by friction with suitable seats provided for them in the pulleys, are of steel, and are cut through at opposite points, and so formed as to have a certain amount of spring within themselves, in addition to which there is some spring in the vertical arm which shifts the clutch, the two yielding points obviating all shock. The motion of the clutch is very slight, and full provision is made for taking up wear at all points, including the fork and the groove in which it works. Hardened steel collars are used to keep the pulleys in place, and to take the thrust of the shaft, which is supported in three bearings, and carries a hardened steel worm, running in oil and driving a phosphor bronze worm-wheel, which is at the end of the transverse shaft passing under the ram slide.

Under the ram are two racks, one at each side of the central line, and engaging with these racks are two pinions 8″ diameter, these pinions being on the transverse shaft spoken of, and separated from each other a sufficient distance to admit of a shaft that is to be key-seated being passed through between them under the ram and over the shaft. The peculiar method adopted for making these racks and their pinions is worthy of some attention. Steel screws are first made in the lathe 2⅝″ diameter 1″ lead double threads, the threads being the proper shape for rack teeth. These screws are then divided lengthwise by milling into three pieces, each of which constitutes a rack. Half of the screws are cut right-handed, the other half left-handed; and in attaching the racks to the ram they are put on in pairs, one right and the other left-hand. The pinions, which are of phosphor bronze, are hobbed accordingly, and thus there are two racks and pinions having spiral teeth, and the side thrust of one just balanced by that of the other, producing no side action on the ram nor end thrust on the shaft, and giving a very smooth and steady motion, which, of course, is uniform throughout the stroke. The proportions of the worm-wheels and pulleys are such that the ratio of belt to ram movement is 75 to 1, while quick-return is secured by properly proportioned pulleys on the worm and countershaft. There are also two steps on the driving pulley, so that the cutting speed may be varied if desired.

Feed is obtained by friction plates seen outside the large worm-wheel which move the arm (seen extending below) at each reversal of the motion, its movement being arrested by a fixed stop at the back, and by a movable one in front consisting simply of a screw, which can be turned in either direction to increase or decrease the motion of the arm and the feed while the machine is running. Motion is taken from this arm by means of the usual rod and pawl to the feed-screw. The platen is raised or lowered by means of a fixed screw fitted with a nut, which is in the form of a worm-wheel, and is turned by a worm-shaft, which is at the left of the machine. The knee, which is of the box form, with both its vertical sides finished for the reception of work, has a platen which can be elevated in front by means of the screw as shown, means being provided for clamping it securely at each side for any elevation, thus affording excellent facilities for planing taper work without the necessity for the tedious "blocking up" which must ordinarily be resorted to. The platen is in line with the ram when down solid on the knee. The chuck swivels to any desired angle, having its base graduated for this purpose; and the movable jaw has a piece which slides laterally on the arc of a circle, thus adapting it to hold taper or irregularly shaped work.



A NEW SHAPER.

The machine shown is of 16″ stroke, has a ram 32″ long 8″ wide, table 11″x16″, with a cross motion of 16″. Weight 1,400 pounds.

It is made for, and sold by J. J. McCabe, 68 Cortlandt street, New York.

The "Beck" Twin Compound Engine.

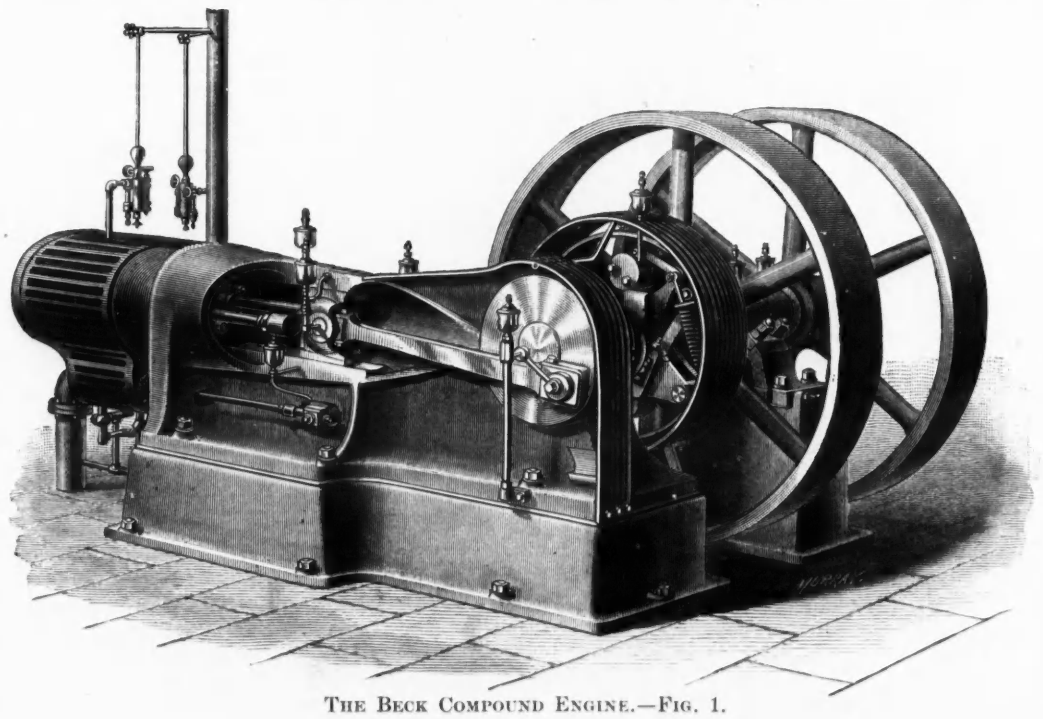
The illustrations on pages 1 and 2 represent the "Beck" twin compound engine, which embodies some new features in steam engineering. Fig. 1 represents an outside view; Fig. 2, another outside view, with the cylinder heads and valve-chest bonnets removed; Fig. 3 represents an elevation, and Fig. 4 a plan of the engine. These cuts plainly show the general design of the engine. Instead of placing the cylinders one in front of the other, as in the type known as the "tandem," they are placed side by side, with one common wall between them, as is plainly seen in Figs. 2 and 4; hence the name "twin." Both pistons are attached to one common crosshead, which in turn is connected by a single connecting rod to the crank-pin.

The valve chambers are also placed side by side beneath the cylinders, with a receiving chamber between them. In engines which have the cylinders placed one above the other in a vertical line, the valve chambers are placed on the side. The valves are of the hollow piston type, provided with L shaped packing rings, which are adjusted or set out by the steam. In designing these valves, great pains have been taken to make them free from leakage, and cause them to remain so through long periods of service. The only parts of the valve which are liable to wear are the packing rings, which can easily be renewed at small expense.

The valves of the two cylinders are operated by one eccentric, which forms a part of the shaft governor. This governor is of the same pattern as used on the plain engine built by the company, and is claimed to give an excellent close regulation, and a high efficiency in the use of steam. The travel of each valve is varied to meet the changes in load, and thus distribute the steam to each cylinder in proper ratio to obtain ease and smoothness of action, and strains on each piston properly equalized.

The pistons are fitted with packing rings, which are adjusted by the steam, and require very little attention to keep them properly set.

The exhaust steam from the high-pressure cylinder is discharged through the port or opening between the valve chambers into the receiving chamber. Caps or bonnets are placed at each end of the chambers; one of these serves as a connection between the end of the valve chamber of the high-pressure cylinder and the port of the receiving chamber, thus making a very short distance for the steam to pass from the ports of the high-pressure cylinder to the receiving chamber, from whence it passes to the valve chamber of the low-pressure cylinder, and is then admitted into the latter cylinder. The short distance through which the steam has to flow from one cylinder to the other prevents a loss of pressure from radiation, as is liable to occur in the ordinary exposed receivers connecting



THE BECK COMPOUND ENGINE.—FIG. 1.

the two cylinders. The wall or side of the receiving chamber next to the valve chamber of the high-pressure cylinder is exposed to the live steam from the boiler before it enters the high-pressure cylinder. This arrangement is advantageous, as it tends to prevent a loss of heat of the steam which is exhausted from the high-pressure cylinder. A further protection is afforded to the exhaust steam by its flow through the piston valve of the high-pressure cylinder. This piston valve is surrounded by live steam from the boiler preparatory to being distributed into this cylinder. The receiving chamber is also of such proportion as to receive the steam without causing back pressure, and to prevent unnecessary expansion of steam before entering the low-pressure cylinder, the importance of which is readily understood by engineers.

The compactness and simplicity of the design will recommend themselves to all interested in steam engines. Each cylinder and valve chamber is as easy of access as in a plain cylinder engine, thereby shortening the time for repairs when these become necessary, which will be appreciated in electric lighting and street railway service.

The plain type of single-cylinder engines of any make can be readily changed to compounds by simply putting on new cylinders.

These compound engines are designed for electric lighting and street railway service, as well as for other purposes, especially marine, for which service a line of vertical engines is being designed; the advantages of compactness being important in marine work, particularly for yachts; they require no more space than ordinary engines; they have no large receivers nor live steam superheating attachments, but are nearly as simple as a single-cylinder engine, and therefore can be handled by any engineer of ordinary intelligence. The makers guarantee a low rate of consumption of steam per horse-power.

The compound engine is patented by R. M. Beck. They are manufactured in sizes from 50 to 500 horse-power, by the Taylor Manufacturing Co., Chambersburg, Pa.; with New York office at 22 Cortlandt street, New York.

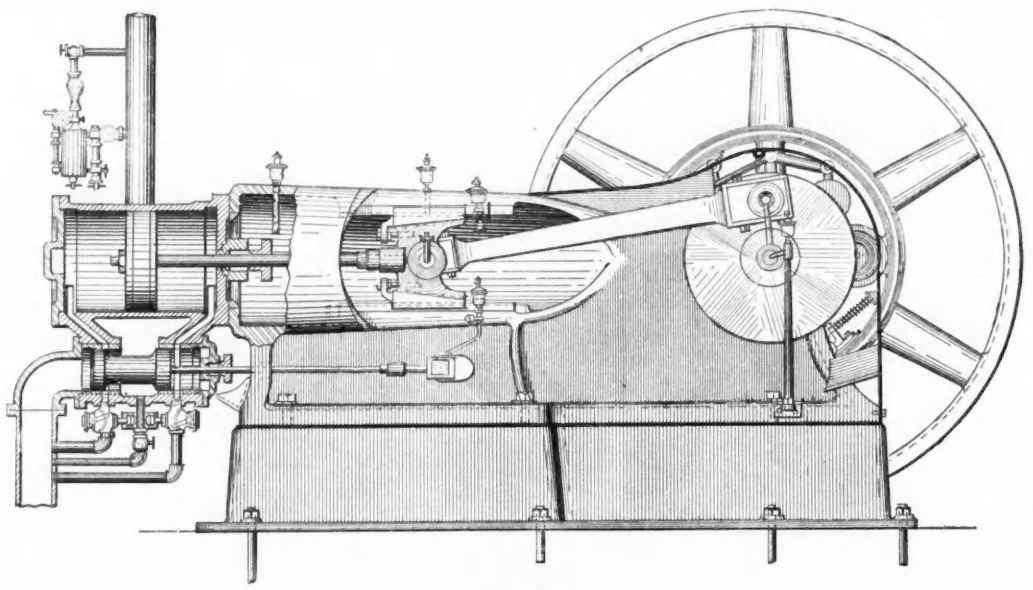


FIG. 3.

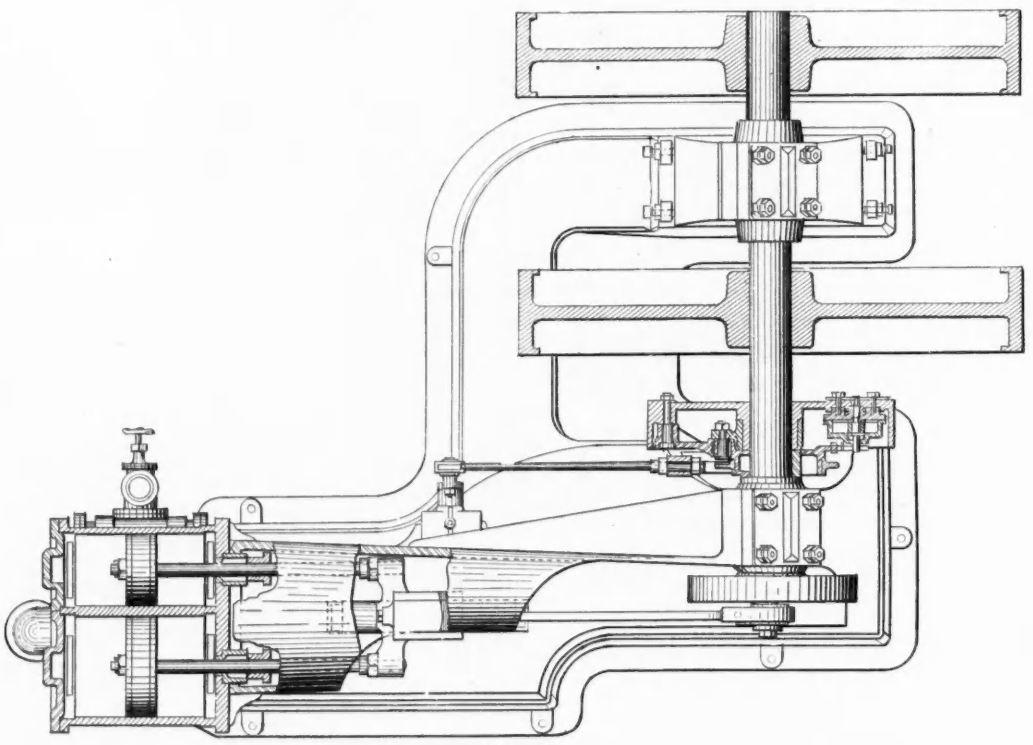
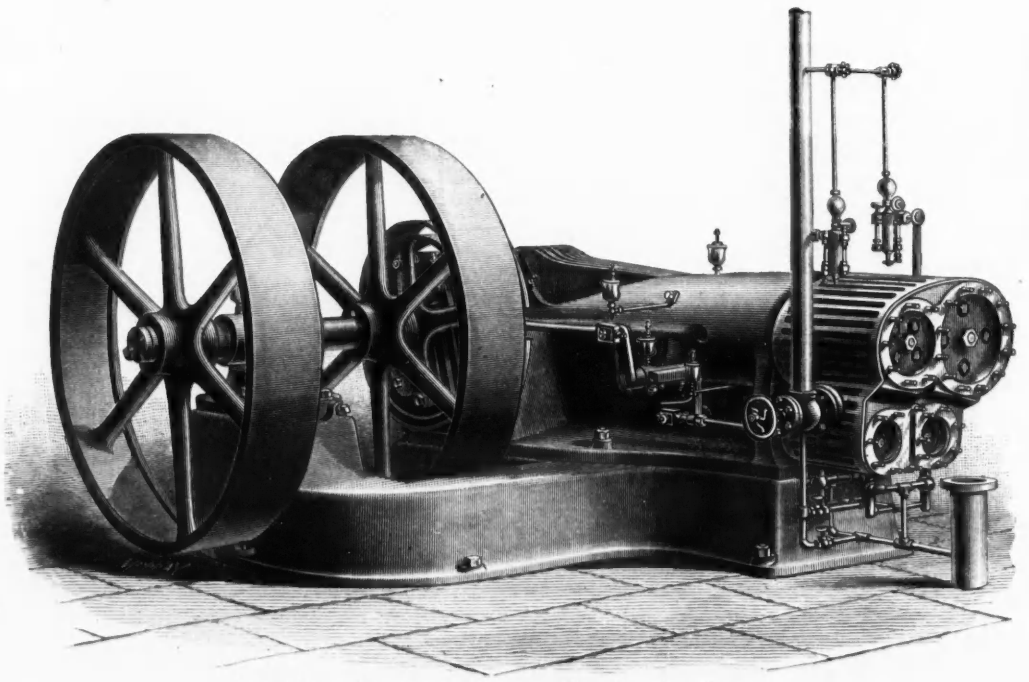


FIG. 4.



THE BECK COMPOUND ENGINE—FIG. 2. SEE PAGE 1.

The Modern Naval Battle.

Each vessel will clear for action as soon as the other is discerned—perhaps five miles away. Each will probably slow down at first, in order to gain time for preparation, and especially for getting the steam pressure up to the highest point. Forced draught will at once be started, and the subdued roar of the air driven through the furnaces to accelerate combustion, and the whir of the dynamos will be added to the clang of the gun-breech blocks as they are swung open to admit the projectile to the breech, the hum of the ammunition hoists raising powder and shell to the decks, and the quiet, firm orders of authority. On deck the Gatling guns and revolving cannon, and the rapid-fire guns in the tops, are got noiselessly into readiness, the captain takes his place in the armored conning tower with the chief quartermaster and his aid, the executive officer assumes charge of the battery, and remains near at hand to take the captain's place in case of his death or disability; the range-finders are got into position, and the officer in charge begins to report from time to time the distance of the enemy, now drawing closer.

Probably not a shot will be fired until this distance is reduced to 2,000 yards, and probably both ships will be pointed toward each other until that time. But now what will the contestants do? It has been held that both will advance steadily toward each other—each commander hoping that some false move on the part of his adversary will enable him to rush forward, discharge his bow torpedo at 500 yards, and, perhaps, follow it up with his ram and end the fight at once—until they have approached so close, say 500 yards, that neither dares to swerve less he himself be rammed; so that the ships will at length collide end on, and maybe both sink.

The various inventions of the past few years—rapid-fire guns, high explosives, torpedoes, submarine boats, dynamite guns and range-finders, the increased power and perfection of steam and electric machinery, the improvements in powder and in steel for projectiles and for armor—have not revolutionized naval science so much as they have broadened it. The principles of strategy remain the same, and so does the necessity for the seaman's skill. Engineers construct, inventors invent, experiments are tried, sham battles are fought, and heated discussions agitate the naval mind, but the only thing that can determine the real condition of modern naval warfare is a modern naval war. —*Lieut. B. A. Fiske in the Forum.*

Standards of Length and Weight.

BY W. H. BOOTH.

From time to time upholders of the metrical system of weights and measures get up a protest against what they are pleased to term the ridiculous and barbarous system, or, as they prefer to term it, want of system, which prevails in England and America.

So far they have not been able to point to any very conclusive evidence in favor of a change. We hear much of want of conformity with nature and natural standards, and yet what do we find? That, taking the basis on which the metrical system of weights and measures is built up, there is nothing definite in fact.

Taking, first, length, it is proved beyond doubt that the meter is not the 10,000,000th part of the arc of the meridian, as it was intended to be. It is, after all, only a length marked on a certain piece of metal, and as such is no more "scientific" than the yard, and far less convenient in practical work. Further, had it been what it professed to be, it could not have remained so, for the earth is changing its diameter slowly.

Taking the kilogram as the weight unit, we find it is supposed to be the weight of a cubic decimeter of water; but this definition is accompanied by the limitation as to the temperature of the water measured, and is absolutely of no use for practical work, for we do not reduce weights of other substances from specific gravities, and as regards naval architecture, sea water is of quite another weight. Temperature again as referred to melting ice and boiling water is of very little importance as to the number of divisions between these two points.

There is seriously no advantage in the meter and its derived units. Is there any in the decimal arithmetic accompanying it? Absolutely none for general work.

There is, for example, no ready method for dividing the circumference of a circle decimally, as there is for dividing it by stepping around with a compass set to the radius.

In nature herself there is very little comformity with the notation of 10, but much on the basis of 4, 6, or 8, and there is no attempt to secure numbers without fractions. We may take it as proven that the period of revolution of the earth round the sun does not even contain a certain number of days, and we are compelled to have years containing an extra day occasionally, and even occasionally to omit the extra day in a year which should have it, and, further still, to omit even the omission, and again take in the extra day at long intervals. Crystals again have 4, 6, 8, 12 and 18 sides, and no arrangement of 10 seems specially convenient for the daily work of life. For general work, articles

are made either on a right-angled basis or circular in one section. A packing case is built on one system, a steam pipe on another, and if an approach to the circular form is called for with the close packing of the angular form the hexagon is employed. How are chimneys built? Either square, round, or octagonal, but never to a decagon. In the division of the circle on its present basis of 360°, we find that the half, fourth, third, sixth, eighth and twelfth have certain of their trigonometrical lines in simple ratios to the radius of $\frac{1}{2}$, 1, 2, $\sqrt{\frac{1}{2}}$, $\sqrt{2}$, $\sqrt{\frac{1}{3}}$, $\sqrt{3}$, and others, whilst the fifth and tenth of a circle do not give such ratios, but apparently near approaches only to such decimals as .3, .7, 3.0, 1.0 with nothing definite. To the steam engineer again the metrical units are aggravatingly near to good ratios. A kilogram per square centimeter is not exactly equal to one atmosphere, but somewhere about it, so there is a *new* atmosphere, forsooth. Nature has had to give way, and the atmosphere is forcibly changed to fit the approximate coincidence of the kilo. per cm^2. What a commentary upon a "scientific" system.

A meter high of water gives 10 kilos per decimeter square, and so 10 meters of water head are pressed into the service as equal to an atmosphere. Wrong again. There is danger in these approximate coincidences.

Applied to money, the decimal system alone appears at all satisfactory, but even here we find the half and quarter of the dollar as customary divisions preferred to the fifth.

In mental calculations the use of decimals is hopeless, and the truth is that the human mind is better fitted to deal in binary divisions and duodecimals than in decimals, and there can be no doubt that the base number of our arithmetical notation should have been 8 or 12 instead of the 10, which arose from the human hand having 10 digits, of which two were thumbs, and should have either been omitted or taken twice over. That our existing system is full of faults I cheerfully admit and allow it should be improved. The usual American ton of 2,000 pounds is an example of simplification; the English weight will follow, and the British gallon of 10 pounds is better than the old gallon to which Americans adhere. Both these items of ton and gallon lead to misapprehension in the minds of readers of technical literature in the two countries.

For the use of chemists and scientists, the metrical system is all very well, and we use it frequently ourselves in certain computations, but for engineering it is not suitable, and we have found a greater proneness to error in using the meter than the foot. So far as regards the greater ease of intercourse with foreign nations, there is far less in this than is claimed by advocates of the change. If a contractor tenders for a foreign contract of excavation at so much per cubic meter, he as likely as not works out his prices at so much per yard, and then translates his pence or cents per yard, into francs or centimes per meter, and there is little doubt that all who ever need it find any difficulty in working in any system of measures. All who have lived much in France or elsewhere in Europe where meters prevail, know that it is not comprehended of the people. In France one buys still by the sou and livre. In Holland the half kilogram is more general than the kilogram, and for freight quotations are given per ton or per 40 cubic feet, the ton being 1,000 kilos, or nearly an English ton, and the foot the English foot, whilst in the engineering shops every one carries a rule with meters on one side and English inches on the other, and drawings are made full of inches, especially in regard to plates and angle irons. Strong practical authorities uphold the present system as more easily understood and simple to figure with than a system of decimals, which is so easy to put tenfold wrong by a slip in the decimal point. We certainly dispute Sir W. Thomson's condemnation of our present system as "wickedly brain-destroying." Little children learn it quite as easily as they could acquire the metrical system, and at the earliest age learn binary division very readily, and from this progress readily on duodecimal lines, whilst decimals are a complete by-road to them. Let us simplify where possible, but on proper lines. Already many unnecessary weights and measures have been dropped, and one rarely hears of them. I was once taken in by an Irish car driver by the statement of a distance being 40 perches. This one instance is the only occasion in life that this measure of a perch has been before me practically, and it was very clear that the Tullamore driver found he could attract fares by stating the distance in an unfamiliar standard. Had he said 220 yards he would have had no fares except from those with baggage.

The decided tendency of the day seems to be to the foot and pound as universal standards for English speaking people, with the gallon of 10 pounds for liquid measure, unless the cubic foot be preferred, and the many old measures, such as rods, etc., are not employed, but simply allowed to lapse as the need for them decreases.

In England the pound of 20 shillings was formerly divided in fourths, eighths, twentieths, fortieths and sixtieths. It was attempted to abolish the eighth and sixtieth, and introduce instead the tenth, or florin, and the eightieth, or 3d. Well the result was that the two new divisions took root, and flourished, but whilst the old sixtieth or 4d. was allowed to die, the public called still for the eighth or half-crown, and it is now recoined and used without any liability to error alongside the florin or one-tenth of the pound.

Decimal divisions are unhandy, simply because 10 is too nearly a prime number, and it seems absurd that a system inaugurated by a few Frenchmen at a time of political excitement should be foisted on cool-headed Anglo-Saxons, who have quietly worked out their own convenient units without either revolutions or bloodshed, and don't feel disposed to change them for a system so inelastic as that based on the meter, and so ill fitted for general work. It must be remembered that in every country women have the spending of most of what is spent of the home trade, which is really the chief trade of a country. How many women could ever reckon their purchases by the decimal divisions of the kilogram? It practically cannot be done. It is not done. They will ask, and do ask for a quarter of a half kilogram, and appear to ignore the kilogram. It is too big a standard for ordinary transactions. One item in a calculation can be decimalized, the money, but not both the money and the weight. If a universal standard is to be adopted, it is worth arguing that it should be one admitting of binary divisions.

Odontics, or the Theory and Practice of the Teeth of Gears.

BY GEO. B GRANT.

FIFTH PAPER.

53.—THE INVOLUTE TOOTH.

The simplest and best tooth curve, theoretically, as well as the one in greatest practical use for cut gearing, is the involute.

The involute tooth system is based on the straight rack odontoid (31), and Fig. 21, and it is illustrated by Fig. 34. If the four odontoids of the rack outline are equally inclined to the pitch line, the resulting tooth system will be completely interchangeable; but if, as in Fig. 35, the face and flank are inclined at different angles of obliquity, $T\ S\ K$ and $T'\ S\ K'$, the system is not interchangeable, although otherwise perfect.

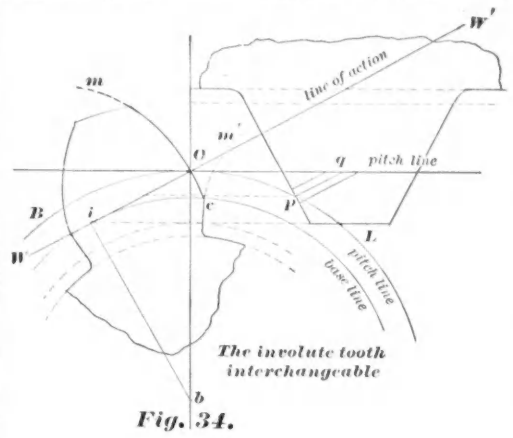
The rack odontoid cannot have a corner or change of direction anywhere except at the pitch line, without causing a break in the line of action.

As the normals $p\ q$ are parallel, the line of action is a straight line $W'\ O\ W$ at right angles to the rack odontoid. The interchangeable line of action is continued in a straight line on both sides of the pitch line, but the non-interchangeable line changes direction at that line.

In accordance with the universal custom we will consider that the involute tooth is always interchangeable, having a single angle of obliquity.

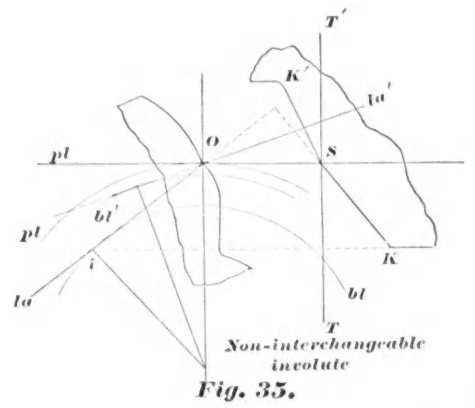
54.—THE CUSP.

As a circle $i\ c$ Fig. 34 can always be drawn



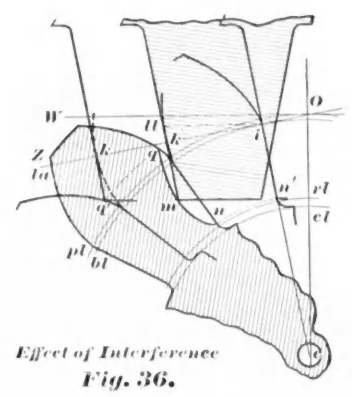
The involute tooth interchangeable

Fig. 34.



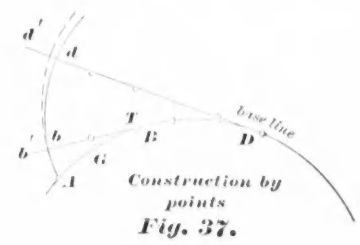
Non-interchangeable involute

Fig. 35.



Effect of Interference

Fig. 36.



Construction by points

Fig. 37.

tangent to the line of action at an interference point i, from the center b of any pitch line B, there will always be a cusp in the curve at the point c (16), and at that point the working part of the curve must stop. The working part of the rack tooth must end at the limit line $i\ L$ through the interference point i.

The working curves of any two teeth that work with each other must each end at the line drawn through the interference point of the other, Fig. 43, being limited by limit lines $l\ l$ and $L\ L$.

The second branch $c\ m'$ of the curve is equal to the first branch $c\ m$, but is reversed in direction. The second cusp is at infinity, and therefore has no practical existence.

The tangent circle $i\ c$, through the interference point and the cusp, is called the "base line."

It is customary to continue the flank of the tooth inside the base line by a straight radial line, as far as may be necessary to allow the mating gear to pass.

55.—INTERFERENCE.

When the point of the tooth is continued beyond the limit line it will interfere with and cut away a portion of the working curve of the mating tooth. Fig. 36 shows a rack tooth working with the tooth of a small pinion, and cutting out its working curve.

This cut is not confined to the flank, but extends across the pitch line into the face, as shown by the line $q\ m\ n$. The rack tooth of the figure will not work with the pinion tooth unless it is cut off at the limit line $l\ l$ through the interference point i.

The mathematical action still continues, and the figure shows the rack tooth in action at k with the second branch of the curve.

56.—ADJUSTABILITY.

An interesting and in many cases a valuable feature of the involute curve, and one that is confined to it, is the fact that its position as a whole with regard to the mating curve is adjustable.

Two involutes, each with its base line, will work together in perfect tooth contact when they are moved with respect to each other, as long as they touch at all. The lines of action and the pitch lines will shift as the curves are moved, and will accommodate

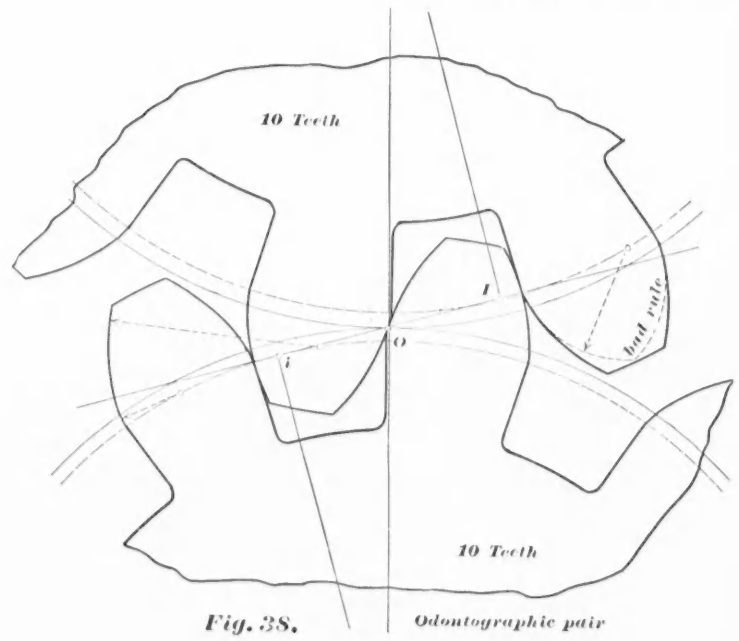


Fig. 38. *Odontographic pair*

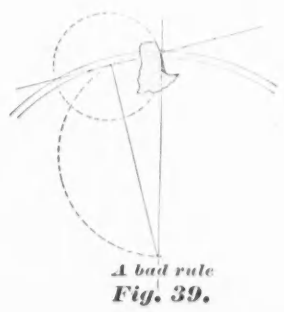


Fig. 39.

themselves to the varying position of the base lines.

But this valuable feature of the involute curve is not always available, and involute teeth are not, as commonly supposed, necessarily adjustable, for the conditions are often such that the teeth will fail to act when the centers are moved, except within very narrow limits. Care must be taken that the arc of action is not so reduced by separating the centers of the gears that it is less than the circular pitch, for the former arc is variable and

the latter is fixed. Care must also be taken that the working curve is not pushed over the limit line when the centers are drawn together.

In any limiting case, such as in Fig. 43, the centers are not adjustable. The gears of the standard set are either not adjustable at all or are so within very narrow limits, on account of the correction for interference.

57.—CONSTRUCTING THE INVOLUTE BY POINTS.

The simple involute curve can be constructed by points by the general method of (24), but it is much better to take advantage of the property that it is an involute of its base circle, and construct it by the rectification of that circle.

As in Fig. 37 any convenient small distance $A\ G$ is taken on the dividers, and the points on the curve located by stepping along the circle and its tangent from any given point to any desired point.

This method is so accurate, if care is taken to step accurately on the line, that the curve seldom needs correction; but, when great accuracy is required, correction can be applied at the rate of one-thousandth of an inch to the step, if the length of the step is regulated by the diameter of the circle according to the following table:

Diameter of Circle:	1	2	3	4	5	6	7	8	9	10	11	12
Length of Step:	.17	.26	.37	.46	.53	.60	.67	.73	.76	.79	.82	.84

For example: If the circle of Fig. 37 is four inches in diameter, and the dividers are set to .46 inch, the true curve, $A\ b'\ c'$, will be outside of the constructed curve $A\ b\ c$ by .002 inch at b and .004 inch at d.

From the table we can form the handy and sufficiently accurate rule that the length of the step should be about one-tenth of the diameter of the circle, for a correction of about one-thousandth of an inch per step.

Having thus found several points of the involute, we can draw it in by hand, or by constructing a template, or by finding centers from which approximately accurate circular arcs can be drawn.

58.—THE STANDARD INVOLUTE TOOTH.

The tooth that is selected for general use, and the one that is the best for all except a few special cases and limiting cases, is the interchangeable tooth having an angle of obliquity of fifteen degrees, an addendum of one-third the circular pitch, or one divided by the diametral pitch, and a clearance of one-eighth of the addendum.

The standard to which involute cutters are made is slightly different, having an angle of 14° 28′ 40″, the sine of which is one-quarter, and a clearance of one-twentieth of the circular pitch.

If the obliquity is 15° the smallest possible pair of equal gears have 11.72 teeth, and therefore 12 is the smallest gear of the interchangeable set.

The base distance, the distance of the base line inside of the pitch line, is about one-fifty-ninth of the pitch diameter, and one-sixtieth is a convenient fraction for practical use.

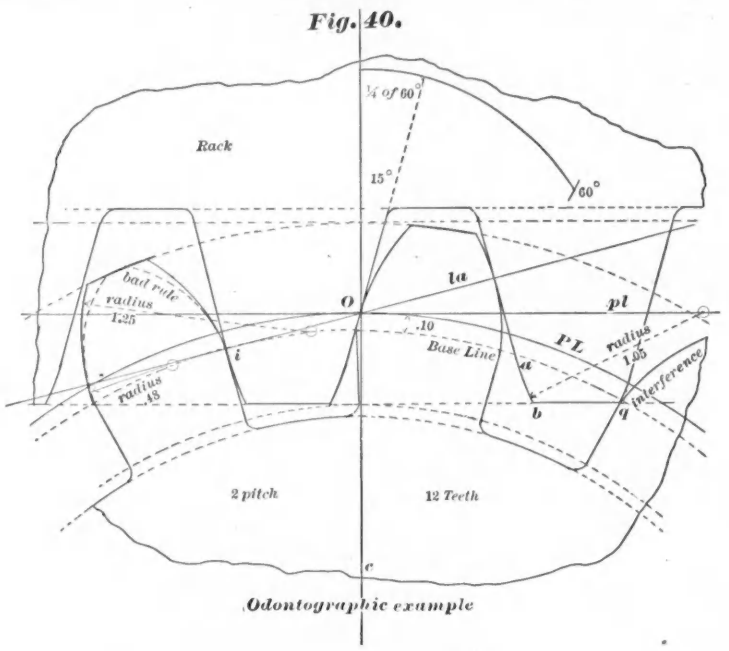
The limit points of the whole set must be determined by that of the twelve-toothed gear, for any gear of the set may be required to work with that one, and the working curve of each tooth must end at the point thus determined. As the limit point is always inside of the addendum line there must always be a false extension on the tooth, the point being rounded over outside of the limit point.

59.—THE INVOLUTE ODONTOGRAPH.

As the base line must always be drawn, it is advisable, to save work, to locate the centers of the approximate circular arcs upon that line. It is also necessary that the points of the teeth shall be rounded over, to avoid interference. These requirements make it impracticable to compute the positions of the centers, and an empirical rule had to be adopted instead.

Teeth were carefully drawn by the stepping method of (57) on a very large scale, one-quarter pitch, giving a tooth eight inches in length. These teeth were corrected for interference by giving them epicycloidal points

Fig. 40.



Odontographic example

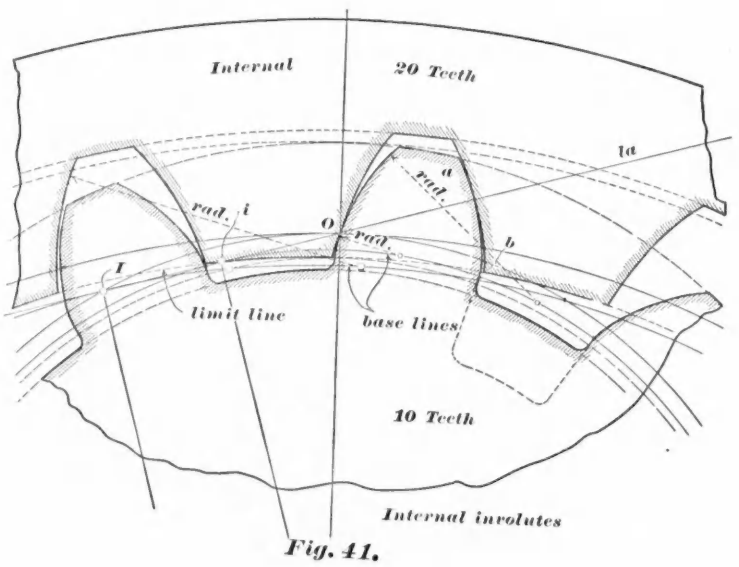
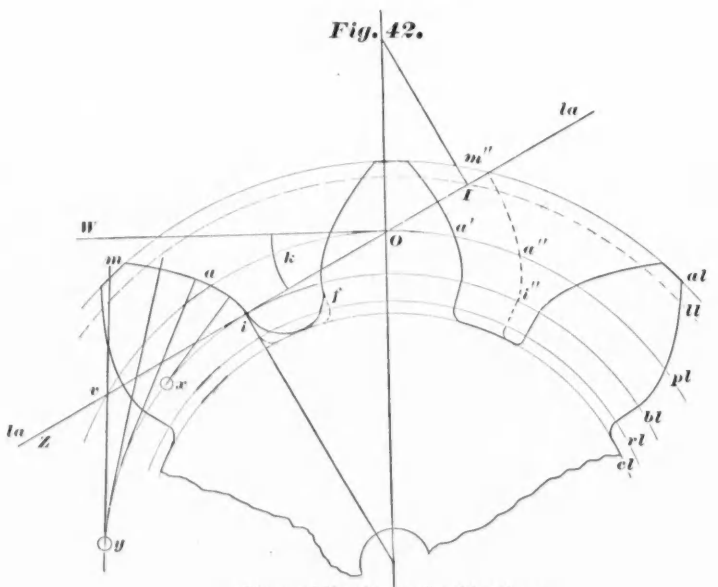


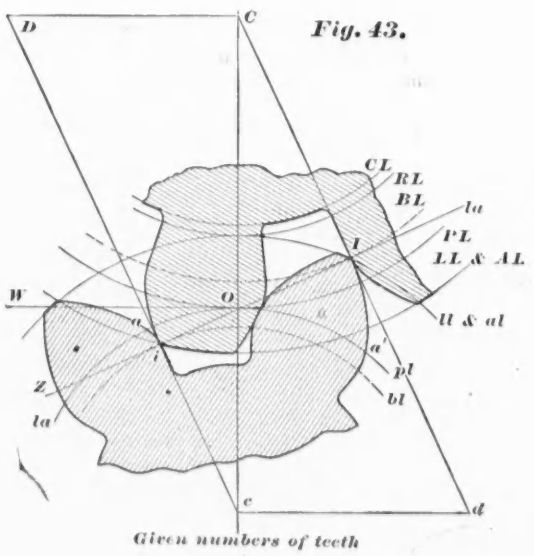
Fig. 41.

Fig. 42.



Given obliquity and addendum

Fig. 43.



Given numbers of teeth

that would clear the radial flanks of the twelve-toothed pinion.

Then the proper centers on the base line were determined by repeated trials, and tooth curves obtained that would agree with the true involute up to the limit point, and still clear the corrected point. The odontograph table is a record of these radii, which are believed to be as nearly correct as the given conditions will permit.

It was found that separate curves were required for face and flank up to thirty-six teeth, but that one curve would answer for teeth beyond.

It was found necessary to devise a separate method for drafting the rack tooth.

60.—TEN AND ELEVEN TEETH.

Theoretically the twelve-toothed pinion is the smallest standard gear that will have an arc of action as great as the circular pitch, but ten and eleven teeth may be used with an error that is not noticeable in practice. Fig. 38 shows a pair of ten-toothed gears in action. They can be in correct action only when the point of contact is between the two interference points i and I, but they will be in practical contact for a greater and sufficient distance.

61.—A BAD RULE.

There is a simple and worthless rule for involute teeth that deserves notice only because it is considerably in use.

It constructs the whole tooth curve, face and flank, for all numbers of teeth, as a single arc from a center on the base line, and with a radius equal to one-quarter of the pitch radius, Fig. 39.

This is wonderfully convenient, but the convenience is purchased at the expense of ordinary accuracy, for the rule is not even approximately correct. It is handy, and nothing else.

Figs. 38 and 40 show the kind of teeth that are constructed by this rule on gears of ten and twelve teeth, where its error is the greatest, and it is reasonable that the involute tooth should not be in great favor with those who have been taught to draw it thus.

The error gradually decreases, until, for more than thirty teeth, it is tolerably correct, but it gives the rack with the straight, uncorrected working face that would interfere, as shown at q, Fig. 40.

As it is tolerable only for thirty or more teeth, and not good then, it may well be dropped altogether.

62.—USING THE INVOLUTE ODONTOGRAPH.

INVOLUTE ODONTOGRAPH.

STANDARD INTERCHANGEABLE TOOTH CENTERS ON BASE LINE.

(*For Table of Pitch Diameters see* 35.)

Teeth.	Divide by the Diametral Pitch.		Multiply by the Circular Pitch.	
	Face Rad.	Flank Rad.	Face Rad.	Flank Rad.
10	2.28	.69	.73	.22
11	2.40	.83	.76	.27
12	2.51	.96	.80	.31
13	2.62	1.09	.83	.34
14	2.72	1.22	.87	.39
15	2.82	1.34	.90	.43
16	2.92	1.46	.93	.47
17	3.02	1.58	.96	.50
18	3.12	1.69	.99	.54
19	3.22	1.79	1.03	.57
20	3.32	1.89	1.06	.60
21	3.41	1.98	1.09	.63
22	3.49	2.06	1.11	.66
23	3.57	2.15	1.13	.69
24	3.64	2.24	1.16	.71
25	3.71	2.33	1.18	.74
26	3.78	2.42	1.20	.77
27	3.85	2.50	1.23	.80
28	3.92	2.59	1.25	.82
29	3.99	2.67	1.27	.85
30	4.06	2.76	1.29	.88
31	4.13	2.85	1.31	.91
32	4.20	2.93	1.34	.93
33	4.27	3.01	1.36	.96
34	4.33	3.09	1.38	.99
35	4.39	3.16	1.39	1.01
36	4.45	3.23	1.41	1.03
37—40	4.20		1.34	
41—45	4.63		1.48	
46—51	5.06		1.61	
52—60	5.74		1.83	
61—70	6.52		2.07	
71—90	7.72		2.46	
91—120	9.78		3.11	
121—180	13.35		4.26	
181—360	21.62		6.88	

Draw the rack tooth by the special method.

To draft the tooth lay off the pitch, addendum, root, and clearance lines, and space the pitch line for the teeth, as in Fig. 40.

Draw the base line one-sixtieth of the pitch diameter inside the pitch line.

Take the tabular face radius on the dividers after multiplying or dividing it as required by the table, and draw in all the faces from the pitch line to the addendum line from centers on the base line.

Set the dividers to the tabular flank radius, and draw in all the flanks from the pitch line to the base line.

Draw straight radial flanks from the base line to the root line, and round them into the clearance line.

63.—SPECIAL RULE FOR THE RACK.

Draw the sides of the rack tooth, Fig. 40, as straight lines inclined to the line of centers $c\ O\ c$ at an angle of fifteen degrees, best found by quartering the angle of sixty degrees.

Draw the outer half $a\ b$ of the face, one-quarter of the whole length of the tooth from a center on the pitch line, and with a radius of

2.10 inches divided by the diametral pitch.
.67 inches multiplied by the circular pitch.

64.—DRAFTING INTERNAL GEARS.

When the internal gear is to be drawn, the odontograph should be used as if the gear was an ordinary external gear. See Fig. 41.

But care must be taken that the tooth of the gear is cut off at the limit line drawn through the interference point i of the pinion. The point of the tooth may be left off altogether or rounded over to get the appearance of a long tooth.

The pinion tooth need not be carried in to the usual root line, but, as in the figure, may just clear the truncated tooth of the gear.

The curves of the internal tooth and of its pinion may best be drawn in by points (57), for the odontographic corrected tooth is not as well adapted to the place as the true tooth, and no correction for interference is needed on the points of the pinion tooth or on the flanks of those of the gear.

Care must be taken that the internal gears do not interfere by the point a striking the point b, as they will if too nearly of the same size.

A Use for Inertia in Shaft Governors.

BY E. J. ARMSTRONG, SYRACUSE, N. Y.

(A Paper Presented at the Cincinnati Meeting of Mechanical Engineers.)

In presenting this paper to the society, the writer does not presume the ideas to be new to all. Talleyrand said: "There is nothing new, except that which is forgotten"; and in the exhaustive study which has been given to the many obscure problems of engine governing, it seems improbable that this one should have been overlooked. It has not, however, been generally recognized, and the writer has failed to find any literature bearing on the subject.

It seems to be demonstrable that inertia, usually a disturbing element, can be and is made the reverse, even to performing the functions of a dash-pot. To one having some experience with shaft governors, it would at first appear singular that certain governors should be capable of close regulation, without introducing an oscillatory action, fatal to good governing. With a fly-weight moving a considerable distance, a moderate speed, and friction reduced to insignificance, it would seem that were any efforts made toward close regulation, all the conditions for a first-class revolving trip-hammer would be present; and yet these governors run smoothly, even when adjusted very nearly to isochronism, within one-half of one per cent. in some cases.

The reason for this steadiness under apparently adverse circumstances seems to be about as follows: When any governor is engaged in its task of controlling the engine, the fly-weight travels at a variable speed, resulting from its revolving in a circle of variable size; this change in velocity is often quite considerable, depending, of course, on the amount of radial movement and the rotative speed. To take an example from the straight line engine—a fly-weight is 16¾ inches from the center of the shaft when "in," and 20¼ inches when "out," making, at 220 revolutions per minute, a difference in velocity of 194′ 4″ per minute. Whenever the fly-weight takes a new position it must change its speed—must either move faster or slower, be accelerated or retarded, and either absorb or give out power—somewhere. This resistance to a change in velocity acts at right angles to a radial line, drawn through the center of gravity of the weight, and if the weight were pivoted so as to move radially, as in Fig. 180, the only result would be to put a pressure on the pivot. If the fly-weight is pivoted, as to move at an angle to a radial line, as in Fig. 181, so that in its outward movement it goes towards the way the wheel rotates, then the outward movement of the fly-weight will be opposed, to some extent by this resistance to acceleration, depending on the angle which the line of movement forms to a radial line—or, to put it another way—upon the length of the lever arm $a\ b$, $c\ a$ being the line of resistance, and b the fly-weight pivot. When the weight moves toward the shaft, the action is the same. It has to part with some of its momentum, and so hangs back, as in its outward movement, thus making, similarly to a dash-pot, a resistance to movement in both directions, which can only be overcome quickly by a great force, or by a small one slowly; this resistance increases as the velocity of the weight, which is all which is accomplished by the ordinary dash-pot. Fig. 182 shows a fly-weight pivoted so as to

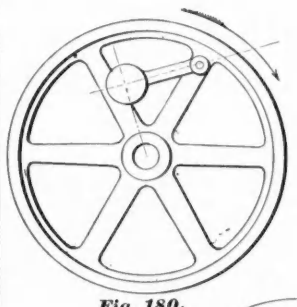


Fig. 180.

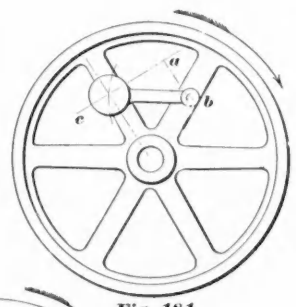


Fig. 181.

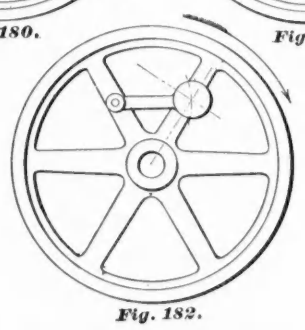


Fig. 182.

move at an angle to a radial line, but in the opposite direction to Fig. 181. A number of governors have been constructed on this plan, with the idea that any sudden jumping ahead would tend to leave the fly-weight behind, throwing it outwardly and shutting off steam, or *vice versa*, in case of a sudden retardation of the engine; the whole scheme being to make the governor very sensitive to changes in speed. In the variable velocity of the fly-weight we may find the reason why these attempts have not proved more successful. As the fly-weight starts to go "out" it has the velocity due to its distance from the shaft; being pivoted so as to swing back freely, there is nothing to give it the greater velocity due to its increasing distance from the shaft until it gets it all at once at the end of its movement, with a slam not at all reassuring to the designer. Then, when it starts to go toward the shaft it has a high velocity, and does not part with it until it strikes bottom. Of course a dash-pot will cure it, but is it good engineering to build governors that way? At the beginning of this paper, mention was made of the absence of friction as an unfavorable condition. Of course any considerable friction in a governor becomes a serious fault, but a small amount, such as is present in nearly all governors under the most favorable circumstances, would seem to be rather of advantage; the friction and inertia of the valve and its connections are usually sufficient to keep up a slight vibratory movement in the governor, and when this is the case the fly-weight will move very easily if it only moves slowly, the friction coming into full effect should the weight attempt a more rapid change of base. This of course does not apply in the same degree to those governors having a locking or wedging action, and uninfluenced by valve friction or inertia.

Practical Details of Case-hardening.

BY B. F. SPALDING.

OBJECT OF THE PROCESS—FIRST PRINCIPLES — MATERIALS — VARIED EFFECTS — WHY FERROCYANIDE OF POTASSIUM HARDENS—HARDENING CAST-IRON—RED-HOT BATHS—METHODS OF USING CHEMICALS—VARIETIES OF BONE—PLAGUES OF OLD LEATHER—CAUSE OF COLORS — METHODS OF PRODUCTION.

Iron may have the outside hardened as hard as steel, and this hardened portion may be made to extend to a greater or less depth. The process by which articles are thus enclosed in a hard coat is called case-hardening. Whether they actually are, or are not, enclosed in a case or box, to perform the operation, the term is still applied. It refers rather to the effect produced than to the manner of producing it.

The term case-hardening is applied indiscriminately to processes intended: (1) to harden only; (2) to harden and color; or (3) to simply color articles made of iron.

In speaking of iron, one may generally include any of its combinations, such as the mild steels, which, when heated in the open fire, and quenched in cold water, will, when bent, take a permanent set. When articles are to be case-hardened it is important to make a distinction, as iron combined with variable quantities of other substances requires some variation in treatment. The process which will simply color articles made of Norway iron will suffice to both color and harden pieces made of mild steel. In the process of case-hardening the surface of the article is first changed to steel. This change in the nature of the material having been produced, the hardening itself follows the general laws which govern the hardening of steel.

The change of iron into steel may be by the association of phosphorus or carbon with its particles. There are other substances employed in other steel-making processes, but in case-hardening, with the materials in common use, these two, carbon and phosphorus—either one or the other, or both together, are the elements which produce the change in the character of the iron.

The materials used for case-hardening are bone, old leather and other animal substances, which can be converted into animal charcoal, and prussiate and cyanide of potassium. The change is brought about by bringing these materials into close communication with the iron while it is at a high temperature. When iron is subject to these conditions, the hardening elements, in a gaseous state, enter among its loosened particles, enveloping them and permeating through, and forming a permanent union with them. As the gases enter the outer particles first, and through them affect those contiguous, the depth to which they will penetrate is a question of the length of time during which these favorable conditions shall be preserved.

With bones from the rendering establishments, from which the animal matter has been extracted, a phosphorus steel is produced; with fresh bone, a mixed carbon and phosphorus steel; with animal charcoal from leather, a carbon steel, and with prussiate and cyanide of potassium, a carbon steel.

Prussiate of potash is made from iron, potash, and animal charcoal obtained from blood, hoofs, horns, hides, leather, or similar animal products rich in nitrogen. These substances in other forms are used to convert iron into steel, and in this concentrated form they act more readily and penetrate more quickly, and when these qualities are still more concentrated, and the iron element is removed from the prussiate, as it is to form the cyanide of potassium, and nothing is left but the potassium, carbon, and nitrogen, they have so much the more avidity for the hot iron, and so much the more rapidly convert its surface into steel.

Cyanide of potassium is used sometimes to harden steel tools at a low heat. Most temperers regard it as a bastard process. I have been surprised several times to see tools, which I have hardened with it at a low heat, come out of the oil or water pitted as though they were pock-marked. I have never seen any explanation of this phenomenon. As potash has a strong affinity for silicon, perhaps it was owing to the presence of silicon in the steel which was fluxed by the potash. But iron generally contains more silicon, and I have not noticed such effect on iron heated with it in closed boxes.

Cast-iron which cannot be made hard by simply heating and cooling quickly may be hardened by the use of the case-hardening processes, but the hardening is likely to extend entirely through pieces of moderate dimensions. It is on the same principle that cyanide is used to harden steel at a heat lower than it ordinarily requires. There is something curious about this action on cast-iron, which is known to have too much carbon in it already. Why should the addition of more cause it to harden? Possibly because the addition is in the form of cyanogen, and introduces a diffusive element, nitrogen, through whose influence the graphite laying around in lumps is rarefied, associates with the particles of metal, and is converted from cement carbon to hardening carbon. Used on steel, cyanide changes the carbon from one form to the other at a lower heat than the change would otherwise take place. But it sometimes puts on simply a case-harden on the outside without forcing a change throughout, and, therefore, is not a trustworthy process, especially if attempted at an unreasonably low heat. Light bushings for anti-friction bearings for watch machinery may be hardened by its aid in oil, with but slight distortion.

Recipes for various case-hardening mixtures have from time to time been published in the AMERICAN MACHINIST. For locomotive work one is: One pound of saltpeter to eight pounds of leather. The saltpeter must be pounded up fine and sprinkled through the leather, so as not to lie on the articles to be case-hardened. This is not used for getting colors. Making a bath of equal parts of cyanide of potassium and common salt fused together, in which the articles are to be heated until they are red hot, is recommended by one correspondent. Another would add to this mixture a little resin.

Melting a mass of cyanide or prussiate of potash, making a red-hot bath of it, in which articles requiring hardening are to be heated for any desired length of time, appears to be an excellent device for obtaining a uniform heat on articles liable to spring out of shape. They are to be taken out when sufficiently cooked, and cooled either in oil or water. Another way to use these materials is to heat the article which is to be hardened in the open fire, and sprinkle it with, or dip it in the material, which, for this purpose, should be in a powdered form. It may be cooled as soon as the potash melts, or it may be laid back in the fire to soak, and the dipping and soaking repeated until all the benefit possible is derived from the process, after which it must be quickly cooled.

Still another way is to pack an iron-box with a layer of sawdust or granulated (ground or pounded) charcoal half an inch deep, sprinkle on some of the powdered material, place in a layer of the work, sprinkle with the material, level up with sawdust or charcoal, sprinkle on more powder, and add another

layer of the work, and so on until the box is nearly full, then cover and bring to a red heat, and keep up the heat as long as is necessary. Cool in oil or water. When the heat is to be long continued, it is best to use yellow prussiate, with red prussiate mixed with it. The cyanide is probably soonest exhausted, the yellow prussiate gives up later, and the red prussiate (ferrocyanide, or chromate of potassium) stands firing the longest.

A large proportion of the case-hardening is at the present time done with raw granulated bone. This is fresh bone ground and passed through sieves of different sized meshes, to separate it into various sizes, as may be required by the proportions of the work for which it is to be used. Large work requires it to be coarser, so that it will not part with its virtue before the work is hot enough to receive it, and smaller work requires that it be finer, so that it will yield its benefits without keeping up the heat too long. There are five recognized grades, from bone meal up to No. 5, which is suitable for locomotive work.

In the use of leather, there is, of late years, very great difficulty, unless some new scrap leather can be obtained, and most of this is now utilized in other ways. As long ago as 1854 there was no trouble in using old shoes. These were packed in a cast-iron box two feet square and burned to charcoal. This was pounded up as fine as was necessary for the purpose, and used for packing the work without further precaution, but as early as 1860 it was the experience of most every shop doing case-hardening, that they had had a few lots spoiled in some mysterious manner by being galvanized with zinc, so that the work had to be repolished. This was ascertained to be caused by zinc nails in the heels and soles. Then all the old leather had to be inspected and suspicious parts thrown out, until all the soles of old shoes became suspicious, and were no longer considered safe to use. Nothing was left but the tops, and the trouble of getting these compelled a resort, in most cases, to bone. Charred leather yields its useful products more readily than bone, and is fairly exhausted by a three hours heat.

The public is perhaps as familiar with the case-hardening on the Smith & Wesson pistol as with any thing else in the market. Its hardness and beauty of coloring afford a fair sample of what can be done by this process. This work has for the last thirty years been under the personal charge of Mr. James Brierly. He still uses a proportion of leather, which is procured in New York all prepared. He chars the bone himself. In using these materials he does not mix them together, but packs in the box first a layer of leather; then a sprinkling of bone; then the work; another sprinkling of bone; then a layer of leather, and so on until the box is full enough to cover. He heats one hour for colors; three hours for hardening superior to color.

In the Springfield, U. S., Armory, the use of leather has been discontinued and bone is used exclusively. The same is true of the Colt Patent Firearms Co., The Brown & Sharpe Mfg. Co., and I believe also, of The Winchester Repeating Arms Co. The Worcester Machine Screw Co. and The Hartford Machine Screw Co. mix some fine vegetable charcoal with it, diminishing the proportion of bone when case-hardening Bessemer steel, or fine and small iron work.

To get good colors which shall be permanent, the bone or leather should be charred until free from smoke, and, moreover, the work itself should be clean. I have got good colors in box annealing smooth forgings with animal charcoal, but the forgings were clean. Smoke from the packing material makes a coat of soot on the work, and even if the colors come on this they will wipe off with it. Probably the colors do not come out from the iron, but from the packing. It may be gross heresy, but I suspect a trace of sulphur has something to do with them. I have seen them in bituminous coal, some beautiful specimens. An old case-hardener informed me that he had, in making some experiments on glass, packed and heated some of it with his case-hardening, and, not disturbing it until after it had cooled, had then found the variegated colors upon it. They are formed in the box, and are not particularly evanescent if not exposed to the air. If, after the work is heated, it be left to cool off without access of air, the pieces will be found to have all the colors they would have had if they had been cooled from a red heat, with this exception, that they will now have a velvety bloom, like ripe grapes. As the colors are formed in the box, and are destroyed if the pieces remain uncovered long enough for the air to drive away their envelope of gas, it is evident that their passage from the box to the water must be quickly made. A good case-hardener will, however, gauge the height of his box, when he tips or "dumps" out the work, so that the work will have a chance to free itself from the packing before it strikes the water.

The colors exhibit themselves on the iron before it is hot enough to lose the gloss of its polish. If it is taken out at this stage, it will have the brightest and most variegated hues, from a golden luster to a burnished black, but they will not be durable, and the work will not be hard. Badly prepared material, too long continued heat, and access of air, will prevent getting good colors.

Nat Hancock, an expert, and widely-known gun contractor, had a contract on the Greene rifle, at the old Waters' armory, in Milbury, in 1860. The case-hardening of the locks was included in his contract. One of the furnacemen from Washburn & Moen's Quinsigamond Works, in applying for the job, said: "I can make steel out of the very dust of the earth, and I can case-harden so that the pieces will come out of the water looking like partridges!" Nat was sportsman enough to be struck by that simile, and hence put the man to work. The genius did not get his material fixed right, nor his cover, nor his heat, and when the work was dumped it came out of the water a dingy, dirty, muddy black. Nat's expression on this occasion passed into a byword. "Partridges! man," he said contemplatively. "You are mistaken! You must have meant crows."

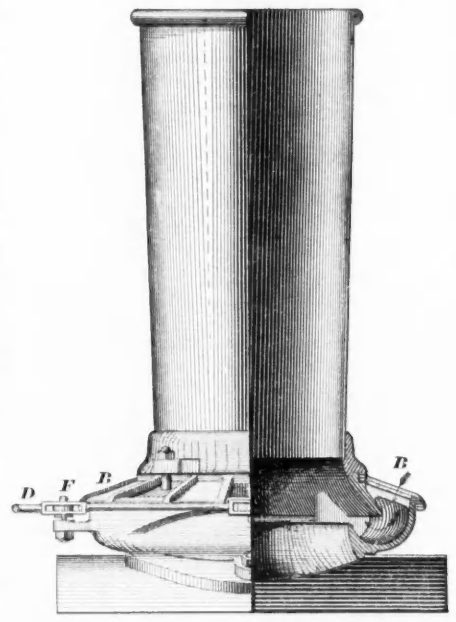
Due attention to the character of the materials used for case-hardening and their peculiar effects having required so much space, the further details of the process must be deferred to a future issue.

The Petroleum Fields of India.

A London lecturer recently stated that in India petroleum occurs in Upper and Lower Burmah (including the Arakan Islands), in Assam, in the Punjab and in Beloochistan, and described in detail the various deposits, as well as the steps which have been taken to render them commercially available. In Arakan the most productive fields were believed to be those of Ramri and the eastern Baranga Island, in both of which localities petroleum of a very high quality, in some cases sufficiently pure to be capable of being burned in ordinary lamps in its crude state, was obtained. The well-known oil fields of Upper Burmah, situated near Yenangyoung, the product of which has long been an article of commerce, were next described. In his account of the Punjab oil deposits attention was directed to the importance of the results, especially from the point of view of providing liquid fuel for use on the railways, which has attended the drilling operations at Khatan, in Beloochistan. The lecture was illustrated by a large number of typical samples of crude petroleum from the various districts enumerated, and full particulars were given of the physical and chemical characteristics of these samples. In India, as in Russia and Galicia, owing to the disturbed character of the strata in which petroleum is found, drilling is attended with difficulties. The most abundant supplies of oil were those obtained from the wells at Khatan, any one of the five wells already drilled being capable of furnishing the entire supply of 50,000 barrels of oil a year, which is estimated to be the amount required for the Sind-Pishin section of the Northwestern railway. From the point of view of the kerosene manufacturer the Arakan oil was the best, but on the other hand, much of the Yenangyoung oil yielded a large percentage of paraffine, which was a valuable product; and the yield of kerosene from the latter oil was capable of being largely increased by the adoption of a process recently devised by Professor Dewar and the lecturer. Too little was at present known about the oil fields of India to admit of a confident prediction as to their future. But it was pointed out that, unless the necessary operations were carried out under skillful, energetic and experienced management, disappointment and discouragement would probably ensue, and the development of the oil fields of India would be retarded. The action of the Indian government in proposing to sell the oil-producing territories in sections, instead of granting prospecting licenses, was commended as being likely to afford some guarantee for efficient development.—*London Times.*

Luttgens' Variable Exhaust Damper for Locomotives.

The illustrations represent the latest design of Luttgens' variable exhaust damper as applied to the tapered stack, which in late years has been extensively adopted on many railroads, particularly in connection with the extension front. The damper is very simple in construction, and can be readily applied to any stack by simply removing the base of the stack and putting the damper in its place. It consists of a cast-iron ribbed register plate *B* resting upon the turned surface, covered with an improved Chinese soapstone paint; this paint is heat-proof, and enters into the pores of the cast-iron, forming a hard and durable protection for the iron. The register plate is provided with a number of openings which correspond to the apertures in the base. The register plate is connected by two links to the lever working on the fulcrum *F*, and this lever is worked by the rod *D*, which extends into the cab, and is so arranged that either the engineer or fireman can open or close the apertures in the base. In the plan of the stack these apertures show partly open, and in this position air is admitted into the bottom of the stack as indicated by the arrows at *B* in the elevation.



Damper for Locomotives.

With this device the engineer is enabled to regulate the draught as required, by admitting more or less air, or shutting it off at will. The advantage of regulating the draught in this manner will readily be perceived; it does away with the necessity of opening the fire-door, admitting a current of cold air into the furnace, which often results in injury to the furnace sheets and flue joints. Evidence also seems to indicate that with this damper a considerable saving of fuel can be secured. On the switching engines on the Long Island Railroad, the damper is closed at first upon a new fire, but during the remainder of the day the engine is run with an open damper; the result claimed for this is a noiseless and smokeless engine, without waste of steam at the safety valve, and using from 3,000 to 4,000 pounds of inferior coal, where three tons would be about the usual allowance. These switching engines have 18x24 inch cylinders, and are on the move continuously. In other cases it is claimed that a saving of fuel of 15 to 30 per cent. has been secured; although we have no reason for doubting these statements, it seems hardly possible that so favorable results can be obtained in every case. Many of these dampers have been put in practical use, and seem to establish an excellent reputation; whatever merits may be attributed to these dampers, it is evident that they correct some defects in the steaming of a locomotive. In the southern States there are forty-six engines with these dampers, and it is claimed that they have proved themselves valuable on account of their spark-arresting quality, and have prevented fires in the cotton districts.

At present, five passenger locomotives for the Long Island Railroad, in course of construction at the Cook Locomotive Works, are being fitted with these dampers; three locomotives for the New York, Providence & Boston Railroad in course of construction at the Rhode Island Locomotive Works; and one passenger engine for New York, Susquehanna & Western Railroad, at the Rogers Locomotive Works, are also having these dampers put on them. The address of the inventor is H. A. Luttgens, P. O. Box 131, Paterson, N. J.

In regards to the stack itself, shown in the illustration, it may be of interest to note that this form of stack is often considered to be a modern form, when, in fact, the tapered stack was introduced by Mr. William S. Hudson on engines built by the Rogers Locomotive Works some twenty-five years ago. The only difference being that Mr. Hudson's stack was not quite so large in proportion at the top, and through a short distance was also tapered to a larger diameter at the bottom, and the whole covered with a cylindrical shell, making it appear like a perfectly straight stack.

The Mechanical Theory of Chimney Draught.

By J. Burkitt Webb, Hoboken, N. J.

(A Paper presented at the Cincinnati Meeting of Mechanical Engineers.)

In a previous paper the statement was made that when the draught of a chimney is produced by the heat of a furnace its velocity does not depend directly upon the expenditure of heat, and therefore is not a problem in thermo dynamics. It was further stated that the velocity depended directly upon the action of gravity, and the phenomenon was likened to that of a clock, whose speed of running is controlled by a pendulum. By the winding up of a weight, energy is stored, and thus placed at the disposal of the mechanism, but the rate at which the mechanism uses the energy is controlled by gravity.

The chimney may also be compared to a

vessel kept full of water, which is allowed to flow out of a hole at the bottom; the velocity of the issuing jet depends upon the head of water in the vessel, and so in the chimney the velocity of the issuing hot air depends upon a head of hot air. In both cases, if the flow is to be kept up continuously, as much must be supplied as flows out, and this requires water to be lifted in the one case and air in the other.

We shall in this paper show exactly how gravity acts in producing the velocity of the hot air in a chimney, and how the heat acts in producing the velocity of the hot air in a chimney, and how the heat acts to keep gravity wound up, so to speak.

Let *C D* (Fig. 139) be a chimney, say, 330 feet high by 1 foot square section, full of hot air, and let *A B* be a shaft 100 feet square, of the same height, full of cold air, *B C* being a passage connecting the two. For the sake of simplicity we shall assume that the air in the chimney is so hot that its density is but half that of the cold air, and that, after the air is heated, no heat is abstracted by a boiler or lost through the walls. By placing the grate near the bottom of the large cold-air shaft it will be so large as to offer no perceptible obstruction to the passage of the air, and we may also suppose that the grate bars are simply wires capable of being heated by electricity, so that there will be no coals to obstruct the flow, and so that the heat can be turned on and off by making and breaking the circuit. Let *E F* be such a grating of wires.

The cold-air shaft having 10,000 times the section of the chimney, and the cold air only half the density of the hot, the velocity in the shaft will be but $\frac{1}{20000}$ of that in the chimney, and therefore neglectable.

It must be evident at once that, if the chimney be in full draught and if the current be broken so as to stop the supply of heat, no diminution of the velocity will result until all the hot air between *F E* and *C* has passed into the chimney. But this space *F E C* can be made of any capacity, so that the effect upon the velocity of stopping the supply of heat can be postponed indefinitely, which proves that *the heating of the air has no direct effect in producing the velocity.*

We have therefore to consider separately: *The effect of heating the air, and the production of the velocity.*

The pressure of the atmosphere at *A* and *D*, being the same, may be left out of the problem.

THE EFFECT OF HEATING THE AIR.

Suppose the chimney to be in full draught, the hot air issuing at *D* with a velocity of, say, 100 feet per second, and let the heat be shut off. During the next second 100 cubic feet of hot air will escape at *D* and an equal volume will pass out of the cold-air shaft through the grating without undergoing any expansion, so that the upper surface of the air in the shaft must fall $\frac{1}{100}$ of a foot. Suppose, in the next place, that there is no draught in the chimney, a damper at *C* being closed, and let the grate be of such capacity as to hold 50 cubic feet of air, which we will suppose to be cold. Now close the circuit and heat the air until it expands from 50 to 100 cubic feet. This will raise the surface of the air at *A* $\frac{1}{200}$ of a foot.

When the chimney is in full draught and the heat supplied continuously both of these processes are going on together. The surface at *A* is falling $\frac{1}{100}$ of a foot each second, on account of the flow of the air, and it is being lifted $\frac{1}{200}$ of a foot, by reason of the expansion of the air, the two operations being independent of each other.

The effect of heating the air is then simply to keep raising the cold air in *A B*, which acts as a weight to keep the apparatus running—*i. e.*, to keep the chimney drawing—one-half of this weight being balanced against the weight of the hot air column, and the other half being employed in maintaining the draught.

In some clocks the operation of winding interferes with the running; in others it does not. I once arranged an astronomical clock in a manner corresponding so exactly in its principle with that of chimney draught that a description of it may advantageously be given. *A* (Fig. 140) is a pendulum clock. *B* is the main arbor to which the power is applied; on this arbor is a wheel, with a V groove in its periphery, around which passes an endless cord. This cord passes also around a similar wheel *C*, free to rotate in the direction of the hands, and sustains a larger and a smaller weight, as shown. By rotating the wheel *C* the clock can be wound without interrupting the action of the weight upon *B*, whereas in an ordinary clock, with a cord simply wound on a drum at *B*, the winding up of the weight interrupts its pull on the shaft *B*, and may cause the pendulum to lose a beat, or, if the winding is done very slowly, the clock may stop.

There is nothing to prevent the winding from being done so slowly as to become a continuous operation, the weight being lifted each second the exact distance that it falls, so that it remains stationary.

We may easily vary the construction in Fig. 139 so as visibly to separate the action of raising the weight from that of producing the velocity.

Suppose (Fig. 141) that the cold-air shaft be extended to twice its former height and connected at the top with a similar shaft *G H*, opening at the bottom with a grating of wires to heat the entering air.

The atmospheric pressure must be supposed the same at *A* as at *D*, and it could be made so by having a gasometer top *A H*, with sufficient weight to make up for the different actual barometric pressures at *D* and *A*.

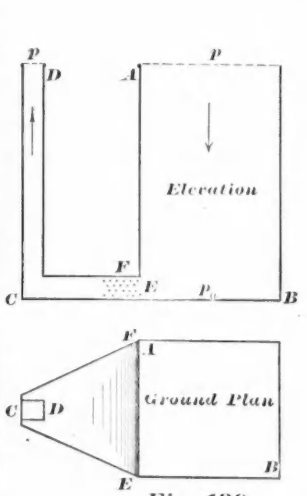


Fig. 139.

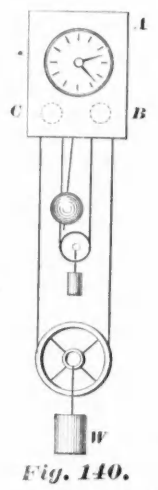


Fig. 140.

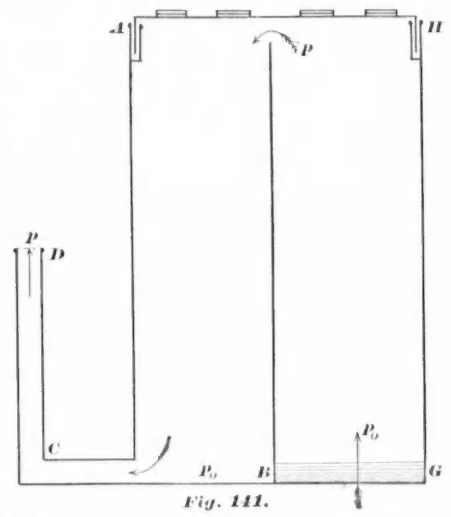


Fig. 141.

CHIMNEY DRAUGHT.

In such an apparatus the hot grate would keep *G H* full of hot air, having substantially no velocity, the action of the heat being to make each cubic foot of cold air 2 feet high or to expand a column half *H G* high into one with the height *H G*, the weight remaining the same, so that the hot-air column plus the pressure *p*, must balance the atmospheric pressure p_0 at the bottom.

At the top there would be a constant flow from *H* toward *A*, to keep the shaft *A B* full.

THE PRODUCTION OF THE VELOCITY.

The portion of the apparatus *A B C D* would be devoted to producing the velocity of exit at *D*, and this velocity would evidently be that due to the height *A D*, or to the excess of the height of the column of hot air *A B* over that of a column of cold air of equal weight and section.

We shall have, then, $velocity = \sqrt{2g(A\ D)}$.

Were it advisable to take account of the change in density between the bottom and top of the columns of air, we should need a thermo-dynamic formula to express it exactly, but, as this whole change is not 1 per cent. in the height of the chimney, it may be neglected, or, if it be desired to take it into account, the density may be supposed to vary regularly from top to bottom. When it is remembered that both the hot air in a chimney and the cold air outside increase in density downward, and that it is only the difference between these effects that influences the chimney's action, it will readily be seen that there is no use in attempting to include variations in density.

It should be remembered that calculations of chimney draughts are made on the supposition that the chimney is the most contracted part of the air passage, as is usual where plants are properly proportioned. It is quite easy to vary the conditions sufficiently to render changes in the calculations necessary, but it would be useless to consider such cases here, because, were calculations of peculiar cases to be made, it would probably require as much judgment to know where to apply them as to make them. It will be sufficient to say that if the draught be throttled, "so to speak," by an extremely small grate or an impervious bed of coals, or by closing the ash-pit doors, we shall not have the usual conditions. At least it would then be quite out of place to calculate the velocity on the supposition that there was a chance for the chimney to act normally, or to discuss the temperature in the chimney for the production of the best draught. Naturally we should open the ash-pit doors and clean the fire before thinking it worth while to criticise the action of the chimney.

LETTERS FROM PRACTICAL MEN.

Valve Proportions.

Editor American Machinist:

In your very complete explanation of a method for proportioning the ports and D valve of a steam engine, published in the May 1st number, there is one point brought out so clearly, and yet left unsaid, that I would like to call your young readers' attention to it.

When the ports and valve are so proportioned as to cut off at $\frac{3}{4}$ stroke, the lap and port opening are equal, and each just $\frac{1}{4}$ the travel of the valve—so that to proportion a valve to cut off at $\frac{3}{4}$ stroke there need be no more figuring that one can "do in his head" (to use an old expression), except that necessary to get the area of the cylinder and determine the size of port.

I am under the impression that it is not necessary to have the exhaust port opening equal the full steam port opening, when the valve is at the end of the stroke. Hence, in the case you have illustrated, I should make the bridges thicker, leaving the other proportions as they are.

It seems to me a bad example to set students—this leaving the valve seat out wide and flat, with no relief for the valve to run over.

In the case shown there is no reason why the face should not be cut away, so as to leave only the same wearing surface on the seat there is on the valve, and when so cut away the two will probably wear and keep true about sixteen times longer than if made as you have shown them. And, too, when the D opening in the valve is made so excessively high, the rod connection is liable to be set high, also a thing that should be avoided, unless the rod is in some way rigidly attached and guided, so as to prevent the valve from tipping—a thing that it always tries to do and one that it is hard to prevent.

JOHN E. SWEET.

[As to the first point to which Prof. Sweet calls attention, we are led to believe that the whole article was not read, because, in regard to this point we have made the following remarks, which will be found towards the end of the article "It will also be useful to remember that, when the travel of the valve is equal to twice the sum of the lap and width of the steam port, and steam is cut off at $\frac{3}{4}$ stroke, the lap will be equal to the width of the steam port; hence, in the given example the lap was determined as soon as the width of steam port was found, and the construction in Fig. 1 is unnecessary." It seems to us that the foregoing covers the point.]

Making Rolls—Truing Emery Wheels—Indexing.

Editor American Machinist:

In the AMERICAN MACHINIST of April 24, 1890, Mr. C. W. Bender desires some information on rolls, and complains of the iron being spongy. I will say that cast-iron (especially soft iron) has a tendency, when being turned, to pull out, the kind of tool used making no difference seemingly. If Mr. Bender will finish his roll by grinding with an emery wheel, and not taking very heavy cuts, I think he will get a good roll.

In the same paper "Ambitious" writes of using the slide and diamond to true up the water grinder wheel, and says it takes too long. If "Ambitious" will consign the slide to the museum, and lay the diamond away and have it laid away, at least so far as water wheels are concerned, then pull back the rest so as to clear the wheel, and take a piece of flat iron, $\frac{1}{2}$"x3"x5" long, stand it up on edge in front of slide and clamp it (common screw clamps will do), then move the rig up to the wheel, just close enough to get the lugs over of a Huntington emery wheel dresser, or similar device, he can turn $\frac{1}{8}$" or $\frac{1}{4}$" off that wheel in about 60 seconds.

In the issue of October 31, 1889, Mr. Walter Gribben calls attention to milling machine index plates and the differential movement. In the table that he gives he makes mention of 96 teeth or sections, and 105 and other numbers on the B. and S. tables; 105 teeth are not mentioned, but 8 holes on the 21 circle will space 105 as follows:

$$5\frac{40}{105} = \frac{8}{21}.$$

About one year ago I had to cut 96 sections, but as I did not have time to bother with turning forward and backward, I cut 48 teeth, then shifted by the differential $\frac{1}{2}$ tooth and cut 48, making a total of 96. By cutting 48 you turn one way 15 holes on 18 circle. I am certain that there are other numbers that can be cut the same way, as there is no difference whether you divide by 2, or 3, or 4, etc., and use the differential at the beginning, taking advantage of both accuracy and dispatch. G. SCHNEIDER.

There is one pleasant feature in the settlement of the carpenters' difficulty with the employers of New York. The differences were settled almost entirely in favor of the workingmen, but there is no exultation over the settlement. As a model of good sense we append the remarks of Secretary Doyle, of the United Brotherhood. He is reported as saying:

"I hardly like the word strike in this movement. It has been rather more of a series of conferences between the employers and men. We cannot help being thankful to the bosses for their gentlemanly treatment of us during this whole movement.

"They could have caused us no little trouble and expense had they been so inclined. I doubt if there is another city in the country where the bosses have acted as squarely as they have here.

"We appreciate all this, and shall instruct our men to stand by them in the future as they have stood by us in the past."

Secretary Doyle also expressed his regret that Superintendent Murray had deemed it necessary to hold the police reserves in readiness for a possible outbreak.

"Everything has been conducted quietly and peaceably, and at no time during the strike has there been a policeman in the hall, or even in front of it, except as he passed by."

The *United States Miller* puts the number of flour mills in the United States at 16,000

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Water and Water Supply.

One of the greatest wants as well as one of the greatest plagues of the human family, since the days of Adam, has been water, the fluid that covers the greater part of the earth's surface. It is either too plentiful or too scarce; it is where it is not wanted, and not where it is wanted. No wonder, then, that the efforts of mankind, from time almost immemorial, have been to move water either out of the way or into the way. The wells of the ancients were to them places of reverence, and in their religious teachings water played an important part.

The ancients understood quite thoroughly the art of sinking wells, and to them we are indebted for a good deal of present knowledge. Thousands of years ago the Egyptians fully availed themselves of the mechanical knowledge of their day, in the raising of water. It was with them the great thing necessary, not only for drinking and culinary purposes, but for irrigating the land to the end of producing crops. And the fact must be admitted that they used the knowledge then extant to quite as good purpose as men do to-day. In fact, most of the means of raising water practiced at the present day in rural districts can be easily shown to be of very remote origin, although, perhaps, innocently enough "invented."

With the advent of steam as a motive force, what wonder, then, that the attention of mechanicians was turned to its utility in the work of raising water. Thus Newcomen and Cawley's endeavors were to make an engine that should relieve mines of water, as were those of Watt and others.

The steam engine has wonderfully outgrown the early efforts to make it get rid of or to supply water, but to do either one of these things is one of the most important uses to which it is put, up to this day.

Putting aside the work of years ago in the direction of handling water, it can safely be said that the progress of the last 20 years has been remarkable. And this progress has brought about a wonderful activity in cities and towns in the way of looking after water supply.

There are two reasons why this is so. One is—and this operates in the instance of small towns—that it has come to be pretty generally understood that well water is very seldom free from pollution. Even when it seems altogether probable from the surroundings that a well should yield wholesome water, there is no certainty that it will do so. Another reason is that most towns in the country have entered upon a manufacturing crusade; the desire is to attract manufacturers, many of whom require considerable water in the operations of manufacture.

A few years ago the very name of waterworks carried with it the idea of a cost somewhat enormous—so great that only large cities could indulge in the luxury. But there has been great change in this respect. Now, the cost of pumping machinery required for supplying a town of from 5,000 to 10,000 inhabitants is almost nominal and nearly infinitely less than the benefits of a good water supply. The old-time well is a nuisance, except in the country, and experience has shown that even there the water is very likely to become contaminated.

Tentative Processes.

After all the aid of mathematical demonstration and scientific research, about everything relating to industrial operations and the production of machinery has to be worked out by tentative processes. Men learn from their own experience and from the experience of others, and so come to conclusions.

The journal that figures demonstrate to be ample, experience teaches is too small, and the bolt that all calculations show to be strong enough is quite too weak in practice.

There are very few, if any, successful machines that have stood the trial of time in use to-day, the proportions of which have been worked out through a pure process of reasoning. Trial always shows the necessity of alterations here and there, until the final perfect machine comes up.

Still the ability to calculate beforehand is essential. No man can afford to work up a machine through the mazes of guess-work. There are certain things that can and must be fixed, at least approximately, by calculation. But no mechanic should be surprised or disheartened when he finds his calculations have misled him. Then is the time when he should give his common sense and his habits of observation full sway.

One of the latest "fakes" of the newspapers is to get short statements from a number of men who have been successful in any given line of business, regarding their opinions as to how others should proceed to be equally successful. A wealthy man, well acquainted with the history of Boston, gave his opinion the other day on the best manner of accumulating wealth. He said: "All the improved real estate in Boston, as a rule, has paid its interest and taxes and quadrupled in value during the past fifty years, while during the same period 90 per cent. of all the merchants and traders in that city have failed, and 90 per cent. of all the business corporations have either done likewise or gone out of business, so that their stock has been wiped out. In view of these facts I think it may be unhesitatingly asserted that nothing else is so safe an investment for small savings as improved real estate. Nothing is likely to grow in value faster. . . . . If you had a rich father who would furnish you with the cash to start you in business, you would probably do better in the long run if you invested it in the way I have pointed out, rather than risk it in trade, meanwhile earning your living by working for a salary."

We have no doubt this is sound advice so far as it applies to an individual; but if everyone should pursue that course, where would the advancement and development come from by which alone the value of real estate can be quadrupled? If everybody simply invested his money in real estate, and worked for a salary, there would be nobody to carry on the enterprises by which the value of real estate is enhanced.

If the figures given are true, then it ought to be a tolerably easy matter to guess where the money of the 90 per cent. of business men and manufacturers has gone to.

We believe that one of the worst things that can befall a man who works for his living is the habit of investing in goods—furniture and the like—on what is known as the installment plan. The plea that a man has to pay no more for goods bought on this plan than if he paid cash, is not tenable. No honest dealer can afford to sell goods on that basis. But, for argument's sake, admit that it is true. Then it induces a man to run in debt for what he could do without, and it keeps him constantly in debt. His wages are, as it were, always mortgaged. It puts him in a hole, so to speak, out of which he is never likely to get. He can, at any time, buy almost literally without money, and doing so comes to have a certain fascination for him. Through the eyes which he is led to look, things cost nothing, so why should he not buy?

A great many young mechanics, especially in large cities, patronize this credit business. They get married—naturally and properly enough—and then, through a desire to shine, they buy furniture and the like on time. Better buy but little—never so little—and pay cash. There is a wonderful satisfaction in refusing credit when offered. And there is a wonderful sight better chance of getting ahead in the world by doing so. We wish the installment venders no harm, but we advise every honest workingman to shun them.

Within three days of the failing of the Bank of America, of Philadelphia, six banks in southern New Jersey, having intimate business relations with the first mentioned bank, suspended payment. These six banks held in the main the deposits of farmers, fishermen, mechanics and laborers, men to whom the loss of a thousand dollars meant a good deal. It represented, in the instance of many of them, the saving of a lifetime—the money that was to tide over the last year or two, when, in age and from infirmity, they could not work.

We have before spoken of the lax supervision given to banks. If there is anything that calls for strict supervision it is banks in which workingmen and workingwomen are induced to deposit the little they are able to save against old age. Such banks pay depositors a small rate of interest, and it is hardly less than criminal for their officers to jeopardize the principal of their depositors. It is difficult to understand the feelings of those who have nothing but the labor of their hands to gain a living by, upon having their accumulation swept away. Either inspection ought to be thorough, or there ought to be none at all.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(185) A. B., Germany, asks: For what reasons are railway axles made thinner in the middle than at the wheel fits? *A.*—The reason for reducing the diameter of the axle in the center is to reduce the rigidity of the axle, otherwise the constant jar will cause the axles to break at the wheel fit.

(186) J., ———, sends us a small brass casting—a ratchet wheel and stem, from appearance. The casting is a remarkably poor one, and he asks why? *A.*—It is impossible for us to tell. There should be no trouble in making such castings. The mixture appears to be good, but the casting looks as though the metal was overheated.

(187) W. A. J., Augusta, Ga., writes: I want to make a small oscillating engine. I would like to know how the joint is made between the cylinders and steam chest. *A.*—A good and simple way of admitting the steam into the chest, and the manner of making a steam-tight joint, have been illustrated and described in our issue of October 13, 1888.

(188) A. J. H., Algiers, La., writes: Please inform me if a machine is made that will cut out elliptical holes, such as manholes, hand-holes, etc., in boilers or in bridge work; also if compasses or a pair of dividers are made to describe elliptical figures of all sizes. *A.*—We do not know of any machines made for cutting out elliptical holes in boiler work, etc., hand-holes are sometimes punched out. Instruments for drawing elliptical figures are made; one of these has been illustrated in our issue of October 20, 1883.

(189) J. F. M., Bensport, Ont., writes: Kindly inform me whether there are any scientific institutions in the United States in which I could obtain the necessary instructions to qualify me for a marine engineer. *A.*—We know of only one institution in which students are specially trained for marine engineers, and that is the United States Naval Academy, Annapolis, Md. If you wish to fit yourself for merchant marine service, the proper course to pursue is to obtain employment in an establishment where marine engines are built, and in your leisure hours study books relating to marine engineering.

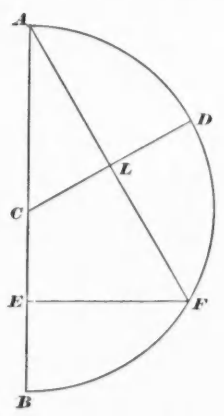
(190) E. L. B., Portland, Me., asks: How is the size of the combustion chamber of a marine boiler determined, say for a common leg boiler, also for the Scotch boiler? *A.*—The first consideration is to give the gases or products of combustion a free escape; therefore the area of the cross-section of the combustion chamber taken at right angles to the flow of the gases should not be less than the cross sectional area of the tubes. The next consideration is the facilities of repairs, which often require the combustion chamber to be made larger than is necessary for the flow of gases, so as to enable a man to calk a leaky joint, flue or rivet. 2. How is the size of the front connection found? *A.*—The same considerations which determine the size of the combustion chamber will also determine the size of the front connection. The size of the latter is in some cases influenced by the consideration of connecting two or more boilers.

(191) H. C. D., Newark, N. J. writes: In a compound engine the high-pressure cylinder is 12 inches diameter, and the low-

pressure cylinder is 36 inches diameter. Suppose the steam enters the H. P. cylinder at 70 pounds pressure, what will be the pressure in the L. P. cylinder? *A.*—The steam pressure in L. P. cylinder will depend on the rate of expansion, which you have not given. The most comprehensive way to find the pressure in L. P. cylinder will probably be a graphical method, as follows: Draw a theoretical indicator diagram corresponding to the ratio of expansion and pressures used as if it were for a single cylinder using all the steam and developing the power required; divide the diagram into two equal areas by a line drawn parallel to the vacuum line, then the distance from the vacuum line to the line which divides the diagram, measured with the scale of pressures, will give you the initial steam pressure in the L. P. cylinder. From the same diagram you can also obtain the mean effective pressure in each cylinder. These pressures will, of course, be only approximate, as the receiver is not taken into account.

(192) J. B. W., New York, sends us the dimensions of two rectangular tanks, and wishes to know how much water each will hold. *A.*—Multiply the length by the breadth, and multiply this product by the depth of the tank, all in inches; the product will be the number of cubic inches which the tank will contain. There are 231 cubic inches in a gallon, hence by dividing the number of cubic inches which the tank contains by 231, you will obtain the number of gallons in the tank. Each gallon weighs 8.331 pounds, consequently in multiplying the number of gallons by 8.331 you will obtain the weight of water which the tank contains. 2. What will be the weight of a column of water in the tank? *A.*—Multiply the depth of water in feet by .434; the product will be the weight of a column 1 inch square, and whose height is equal to the depth of water. This product also gives the pressure per square inch on the bottom of the tank. 3. I discovered a few weeks ago a very useful machine. I wish to know how I can bring this machine before the public; there is nothing of the kind in the market. *A.*—If you have not the means to build the machines and place them on the market, we should advise you to give it into the hands of a first-class business man. If you have means, build them yourself, and advertise judiciously. If the machine is good for anything, you will not have much trouble in making it known to the public.

(193) J. E. M., Cincinnati, Ohio, writes: Please inform me as to the correctness of the following rule: To find the necessary lap for a slide valve when the stroke of the piston, travel of valve, and desired point of cut-off are known. "From the length of the stroke subtract the length of that part of the stroke which is to be made before the steam is cut off, divide the remainder by the length of the stroke of the piston, and extract the square root of the quotient; multiply the square root thus found by half the length of the stroke of the valve, and from the product take half the lead; the remainder will be the amount of lap required." Is there a simpler rule? *A.*—The rule is correct. The lap may also be found by a graphical method, which is sometimes preferred; this method is as follows: Draw the straight line *A B*, and make it equal to the travel of the valve. On the line *A B* as a diameter,



describe the semi-circle *A F B*. On the line *A B* lay off a point *E;* the distance *A E* must bear the same proportion to the diameter *A B* as the distance from the beginning of the stroke to the point of cut-off bears to the whole length of stroke; if, for instance, steam is cut off at three-quarters of the stroke, *A E* must be three-quarters of the diameter *A B*. Through *E* draw a line *E F* perpendicular to *A B*, cutting the semi-circumference in the point *F;* join the points *A* and *F* by a straight line. Bisect *A F* by the perpendicular *C D;* if correctly drawn the line *C D* will always pass through the center *C* of the diameter *A B*. *C L* will be the amount of lap for a valve without lead. From *C L* deduct one-half the lead; the remainder will be the amount of lap required. This method of finding the lap is similar to that given in our issue of May 1, page 5; but in the latter the travel of the valve was not given, and had to be determined as well as the lap; lead was not taken into account, and need not be when the amount is small. When the lead is over one-eighth of an inch, subtract one-half of it from the lap, as found by the diagram.

(194) F. C., Chicago, Ill., asks: What should be the proportions of the steam pipe, steam port, exhaust pipe, exhaust port, lap on steam side, lap on exhaust side, lead on steam side, lead on exhaust side, in comparison with the bore and stroke of the cylinder? *A.*—To find the steam pipe area, multiply the piston speed in feet per minute by the constant .08, and then divide the product by 600; multiply this quotient by the area of the piston in square inches; the product will be the cross-sectional area of the steam pipe; thus, for a cylinder 10 inches diameter and a piston speed of 500 feet per minute, we have

$$\frac{500 \times .08}{600} = .066;$$

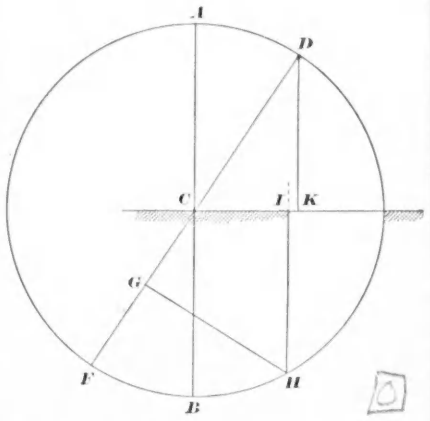
the area of a 10-inch piston is 78.54 square inches, hence $78.54 \times .066 = 5.18$ square inches for the cross-sectional area of the steam pipe; the corresponding diameter is about 2⅜ inches. To find the area of the steam port, multiply the piston speed in feet per minute by the constant .1, and divide the product by 600; multiply the quotient by the area of the pistou in square inches; the product will be the steam port area; hence, for the cylinder and piston speed which we have taken for an example, we have

$$\frac{500 \times .1}{600} = .083,$$

and $78.54 \times .083 = 6.51$ square inches for the steam port area. The exhaust pipe area should not be less than the steam port area; a somewhat greater area will give good results. For the size of exhaust port see our issue of May 1, page 5. The outside lap will depend on the point of cut-off, and the latter is influenced by the initial steam pressure. After the point of cut-off has been decided upon, find the lap as explained in our issue of May 1. The exhaust lap will depend on the duty which the engine has to perform. The lead on the steam side should be such as to make the engine run smoothly. For the lead on the exhaust side good judgment must be used.

(195) J. R. S., Media, Ill., writes: I would like to know whether kerosene or common black oil has a tendency to cause foaming in a boiler. Also what is best to use for loosening the scale in a common 12 horse-power boiler, and how can I prevent foaming? *A.*—Kerosene used in moderate quantities will not make the boiler foam; it is recommended and used for loosening the scale, and for preventing the formation of scale. Neither will a small quantity of common oil always cause foaming; it is sometimes injected into small vertical boilers to prevent priming, and is supposed to have the same effect on the disturbed surface of the water that oil has when poured on the rough sea. Yet oil in boilers will not have the same effect, and give the desired results in all cases, as practice has shown beyond dispute that the presence of oil in combination with other impurities increases the tendency of many boilers to foam, as the oil with the impurities impede the free escape of steam from the water surface. The use of common oil not only tends to cause foaming, but is dangerous otherwise. The grease appears to combine with the impurities of the water, and when the boiler is at rest this compound sinks to the plates and clings to them in a loose, spongy mass, preventing the water from coming in contact with the plates, and thereby producing over-heating, which may lead to an explosion. It may be said that this spongy mass acts similar to water thickened with oatmeal, which, if we attempt to boil it without stirring, will cause the bottom of the kettle to be over-heated. Foaming may also be caused by forcing the fire, or by taking the steam from a point over the furnace or where the ebullition is violent; the greasy and dirty state of new boilers is another good cause for foaming. On the other hand, kerosene is not so liable to combine with the impurities in the water, and is known to attack and remove the scale. Its use for removing the scale may therefore be recommended, but it should be used at first in small quantities, the effect carefully noted, and the quantity increased if necessary for obtaining the desired results. Since we have given the causes of foaming, it will readily be seen what should be done to prevent it.

(196) A. A. F., Carlinville, Ill., asks: 1. How large should the steam pipe be for a cylinder 7½ x 12 inches; number of revolutions, 200 per minute? *A.*—Inside diameter, 1¾ inches. 2. Knowing the width of ports, amount of lead, travel of valve and stroke of piston, how can I find the point of cut-off? *A.*—Describe a circle whose diameter *A B* is equal to the travel of the valve, through the center *C* draw a line *C K* perpendicular to *A B*. From *C* lay off on the line *C K* a distance *C I* equal to the lap, and from *I* lay off *I K* equal to the lead. Through the point *I* draw a line *I H* perpendicular to *C K*, cutting the circumference of the circle in the point *H*. Through *K* draw a line *K D* perpendicular to *C K*, cutting the circumference of the circle in the point *D*. Through *D* and *C* draw the diameter *D F*, and through *H* draw the line *G H* perpendicular to the diameter *F D*, cutting it in the point *G*. Now, consider the diameter *F D* to be



the stroke of piston instead of the travel of the valve, then the point *G* will be the point of cut-off, and the distance *G D* will be the distance through which the piston has traveled from the beginning of the stroke up to the point of cut-off; in other words, if *G D* is ⅜ or ¾ of the diameter *D F*, the cut-off will occur at ⅜ or ¾ of the stroke. 3. Is it a good idea to put a thin sheet of copper between a patch and the crown sheet of a boiler? *A.*—No, it is bad practice to do so, and it should be condemned. 4. Is it good practice to put graphite in engine cylinders as a lubricator, provided it is a good quality mixed with oil? *A.*—We believe it to be good practice; many engineers use it, and some advocate to mix the graphite with water instead of oil. 5. Is it good practice to take rivet heads off the boiler sheets with a blunt chisel and sledge hammer at about two strokes? *A.*—It is customary to do so; and if care is taken not to cut the sheet with the chisel, we do not see any particular objection to it.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 16.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Mech'l Drawings; best; cheap. Box 457, Reading, Pa.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Drop Presses, Punches and Shears. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Adjustable Shrinkage Gauges. Pedrick & Ayer, Philapelphia, Pa.

Link Milling and Slotting Machine. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Well-drilling Machinery and Tools. Williams Brothers, Ithaca, N. Y.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Steel Name Stamps, etc. Address W. G. Sackmann, 1099 First ave., Cleveland, O.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

For Pattern Letters, Steel Stamps, Burning Brands, Mach'y, Plates, &c., A. A. White & Co., Prov., R. I.

F. C. & A. E. Rowland, New Haven, Conn. Hydraulic, Mill and Special Machinery to order.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

For best Return Steam Traps, Pressure Regulators Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See May 1, p. 14. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

25″ Upright Drills a specialty. Finely made,
28″ great capacity, quickly operated, prices low.
32″ Send for list of firms using our Drills. J. E.
36″ Snyder, Worcester, Mass.

25″ 32″ 37″ 42″ "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, Newark, N. J.

Patents.—Patent soliciting of high class. D. Walter Brown, 31 Nassau st., New York. Send for "A Brief History of Patent Legislation in the United States."

C. H. Redman & Co., Newark, N. J., Manufacturers of Light Machinery, Automatic Selling Machines, Telephone and Telegraph Instruments, Sewing Machine Attachments, Models, etc. Contracts solicited.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

Montgomery & Co., 105 Fulton st., New York City, have just issued a small catalogue of 60 pages, containing description and prices of many useful tools. A copy will be sent free to any address upon application.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

Screw Propellers. Manufactured by H. B. Roelker, 22 Cortlandt st., New York. Superintendent of the late De Lamater Iron Works, of same patterns and designs as before, adapted to each vessel. Consulting Expert and Constructing Engineer. Estimates on machinery, damages, etc. Air ice machines.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES

Eastern capitalists will start a shoe factory at Dallas, Texas.

The Sun Enamel Works, Leominster, Mass., will build a new factory.

Ingram & O'Neil will enlarge their machine shop at Huntington, W. Va.

The Pioneer Chair Factory, West Paris, Maine, will be doubled in size.

H. E. Innes is interested in a machine shop to be built at Piedmont, Ala.

W. P. Biddell & Brother have started a machine shop at Knoxville, Tenn.

Lawrence Bros. are talking of building a new saw-mill at Gardiner, Maine.

A $300,000 stock company is being formed to establish a glass factory at Tazewell C. H., Va.

The Bay State Furnace Company has begun the erection of an iron furnace at Fort Payne, Ala.

The Dickinson Paper Company will make extensive additions to their mill at Holyoke, Mass.

It is reported that the Waltham (Mass.) Watch Tool Company will build a factory at Springfield, Mass.

The St. Louis (Mo.) Iron and Machine Works Company are preparing to build a new machine shop.

Howe, Brown & Co., Pittsburgh, Pa., will add a Bement & Miles steam hammer to their hammer department.

Bert, Fox & Co., Pittsburgh, Mass., have built an addition to their brass foundry, which will be used as a machine shop.

The Upson Nut Co., Unionville, Conn., are pushing their buildings to replace those destroyed by fire a short time since.

The Hampton (Va.) Manufacturing Co. has enlarged its foundry, and will put additional machinery in its wood-working factory.

John Fogg & Co., of Boston, Mass., offer to invest $100,000 in the shoe business at Dover, N. H., if the citizens will invest an equal sum.

A cotton factory is proposed at Austin, Texas, to be organized, built and ready for operations by the time the water-power is procured.

A company, with a capital stock of $100,000, has been organized, to operate a cotton factory at Monroe, N. C. A. F. Stevens is president.

The Midway Co., of Roanoke, Va., will erect a factory to cost from $35,000 to $50,000, for the manufacture of railroad spikes, sheet-iron, etc.

A Manufacturers' Association is being organized at Natchitoches, La., and it will make efforts to secure the building of a $50,000 cotton factory.

Essex & Smith, representing a $100,000 Pennsylvania company, have purchased a site, and will erect boiler and engine works at Chattanooga, Tenn.

A company is being organized by J. E. Worsick, at Montgomery, Ala., to manufacture underwear. The capital is to be from $25,000 to $35,000.

The Richmond Cedar Works, Richmond, Va., propose to change their pole road—about twelve miles—to iron or steel. This will call for new rolling stock.

The Menasha Wood Split Pulley Company, Menasha, Wis., are making, for the trade, hangers for shafts of hickory, and are said to be getting a good trade in them.

The Joy Steel Range Company, which was recently burned out at Leeds, Kansas, is about rebuilding and enlarging its factory. The new building will be 70x140 feet.

The Niles Tool Works, Hamilton, Ohio, have issued a special catalogue relating entirely to planers. The cuts are excellent as representative of the planers made at these works.

G. S. Porter, J. E. Doubleday, E. E. Everett and others, have incorporated the International Manufacturing and Supply Co., to manufacture machinery, woodenware, etc., at Chattanooga, Tenn.

The Ashley Wire Company, who operate a plant in the Joliet (Ill.) prison, will be deprived, by law, of their prison labor in July. The company has bought a site with buildings in Joliet, and will continue their business.

The Wilson Manufacturing Co., of Hamilton, Ont., has been incorporated under the Ontario Joint Stock Companies Act, with a capital stock of $30,000. The company will manufacture agricultural implements.

The Tarascon Woolen Mill Co. has been incorporated at Louisville, Ky., with Frank Von Berries, president, and J. M. Fetter, vice-president, to manufacture woolen goods. The capital stock authorized is $30,000.

The Steel Car Trust Wheel Co. is about to erect shops at Edwardsville, Ill. They will be situated on the line of the Wabash Railway, and will be connected by that line and the Madison County Railroad, with all the Eastern roads out of St. Louis.

The King & Hamilton Implement Works, at Ottawa, Ill., were destroyed by fire recently. The works were running full force, and the place was heavily stocked with wagons and farm implements, all of which were destroyed; loss, about $70,000.

The Industrial Wood Manufacturing Co has been organized at Jacksonville, Fla., by Messrs. Onley & Love, to manufacture sash, doors, blinds and other building materials. This company will also engage in a general contracting and building business.

A valve factory is to be started at Rome, Ga., by F. H. Whipple, George Vining and Frederick Bush, of Hartford, Conn., and others. They have incorporated the American Valve Company, and will manufacture valves of every description. The capital stock is $300,000.

The South Tredegar Iron Works, Chattanooga, Tenn., have added to their works a very complete track bolt and nut plant, the machinery being supplied by the National Machinery Co., Tiffin, Ohio. This company has supplied similar machinery to several other large iron works in the South.

The Louisiana Lottery Company is erecting a factory in St. Mary's Parish, La., for the manufacture of sugar. Narrow gauge railroads will ramify to the cane fields, bringing the stock immediately to the mill. Other similar factories will be built, says the New Orleans *Times-Democrat*.

A company is being organized in Pittsburgh, Pa., with a capital stock of $100,000, by Mr. W. T. Paul, manager of the Damascus Bronze Co., and others, for the manufacture of the Smith oiler for car journal boxes, invented by W. O. Smith, of the Lake Shore & Michigan Southern road.

The New Process Rawhide Co., Syracuse, N. Y., send out a catalogue illustrating and describing the goods made by them from rawhide, consisting of gears, hammers, mallets, handles, bearings, washers, etc. The gears made by this company are coming into quite general use for high speeds.

There is water-works agitation at Ashland, Ky.; Machias, Me.; Blacksburg, S. C.; Los Angeles, Cal.; Camden, N. J.; South Pittsburg, Tenn.; Ironton, Ohio; Coldwater, Mich.; Warsaw, Ind.; New Glasgow, N. S.; Somerset, Ky.; Brunswick, Ga.; Malone, N. Y.; Johnstown, N. Y.; Stamburg, Mich.

A corporation to be known as the Wayne Woolen Mills Co. has been organized at Portland, Maine, with a capital of $50,000, for the purpose of manufacturing and selling cotton and woolen goods. The officers are: President, Isaac C. Atkinson, of Portland; treasurer, Frank N. Deane, of Portland.

Crossley Bros., woolen manufacturers, at Lowell, Mass., are having plans made for a new mill at Barre, where they own a privilege. The new mill will be 300 by 65 feet, two stories, with a picker building 100 by 50 feet. They intend to have the buildings ready for the machinery by September 1.

An attachment of $1,000,000 has been placed against the property of the Lowell (Mass.) Machine Shop Company for the heirs of one John F. Fosdick, who was the inventor of a cotton loom, which, it is alleged, the Lowell company has infringed. The agent says the patent expired twelve years ago, and was never reissued.

The people of Lampasas, Texas, are trying to build a railroad from that place to some point on the Austin & Northwestern road. Mr. L. B. Stockbridge says that, in case the new railroad is built, he will grant the right of way through his property free, and donate five acres of ground on which to erect the machine shops.

The Erie Railroad is making extensive improvements along the Weehawken River front. The company will build large freight piers at a cost of $1,500,000. The proposed improvements will provide a freight yard large enough for the storage of 220 freight cars. Work has been begun on the improvements, and they will be finished by next fall.

The Robinson-Rea Co., Pittsburgh, Pa., is building an addition to its foundry, which will increase the capacity by about one-third. The new building is 60x130 feet, and will have an air furnace with a capacity of seventeen tons. Two power cranes will be erected, one sixty tons and the other thirty tons, which will overlap each other, thereby utilizing their combined capacity on heavy work.

The Nova Scotia Steel and Iron Company, New Glasgow, N. S., operating under a new charter granted by the Legislature of Nova Scotia, has issued a prospectus relating to their business. The authorized capital is $2,000,000. The company are now employing about 450 men, and look to increasing the number as soon as they get to work building their blast furnace, etc., which will be immediately.

Recently a syndicate owning land near Greensburgh, Pa., offered to furnish natural gas free for five years, donate ground, and build a plant costing $250,000, if the big table-glass factory near Martin's Ferry, O., would remove there. This plant would be the largest glass works in the world, employing over three thousand hands, and paying weekly $75,000 in wages. The offer will be considered.

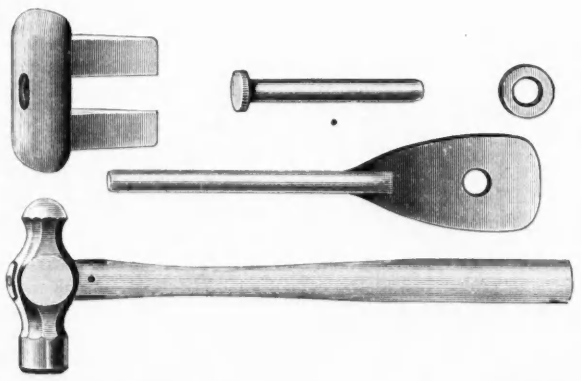
The Northern Furnace Company has been organized at Marquette, Mich., with a capital stock of $100,000, to operate the old Northern furnace, sometimes called the Chocolay Furnace. The furnace has been out of blast since 1867, but is in very good shape, the best of care having been taken of the machinery and property generally. The contract for a supply of charcoal has been let, and the work of repairing the furnace will be pushed. New boilers and a new hot blast will be put in.

A Chicago press dispatch reads: "Senator Gilbert A. Pierce, of North Dakota, in an interview last evening, said: 'We are developing at least two new industries in North Dakota that the world knows little about. Some of our German farmers have been experimenting with the sugar beet, and they have been so successful that hundreds and even thousands will make like experiments this year. The temperature and the prevailing degree of moisture seem to be admirably adapted to the maturing of this vegetable to a point where it contains the greatest possible amount of saccharine matter. All over North Dakota we have veins of soft coal from three to ten feet in thickness, in many places cropping out at the surface. If the beet crop is what it promises to be, arrangements to transform it into sugar will be made on a large scale, the coal supply being an important factor. We have also recently discovered that we can raise the best barley in the world, and indications are that we shall soon raise vast quantities of it, make it into malt, and ship it in that form to the great markets.'"

A Pittsburgh (Pa.) dispatch says: "The firm of Booth & Flinn, whose business as general contractors is more extensive than that of any other in Western Pennsylvania, has taken the initial step toward securing colored labor. The firm has brought this season about 100 negroes from Virginia, and has made special arrangements for additional labor of that character; Mr. Flinn said: 'We have become very much dissatisfied with Italian labor. The Italian is too small, and he does not eat enough of the kind of food to give him strength to do the work required. It is impossible to make him understand anything, and he is always getting into fights and causing trouble. He is entirely too handy with the use of the stiletto. It is true that we have made special arrangements to secure colored labor from Virginia, although not to the number of 800 or 1,000, as reported. However, if we cannot obtain all the colored men in this city that we want, it is most likely that we will draw largely from Virginia.'"

A special to the New York *Tribune*, from Fall River, Mass., says: "The condition of the print cloth market has afforded all concerned much gratification during the past week. Almost the entire production of the capacity of the open mills is represented in the stated production, and even at that the stock on hand increases only slowly, owing to deliveries and spot sales. At $3\frac{7}{8}$ cents for 64x64s the mills have not displayed any feverish anxiety to unload. The stock on hand is held mostly by a half dozen mills, nearly half being held by one mill. The market is firm and strong, but during the last few days it has been much easier to buy than previously. The stock in the Providence market continuous to pile up, shows no signs of moving, and as long as that continues there is little stability to be expected in the local market. The week's production was 210,000 pieces; the deliveries, 207,000 pieces. The stock on hand is 55,000 pieces of 64x64s. Last week's sales were 123,000 pieces, of which 46,000 pieces are odds, and 77,000 pieces are 64x64s; 60,000 pieces are spots, and 63,000 futures. There are sold for weekly delivery in May, 147,000 pieces; in June, 108,000 pieces; in July, 57,000 pieces; in August, 24,000 pieces; in September, 20,000 pieces. The market is firm at $3\frac{1}{16}$ cents for 60x56s, and $3\frac{7}{16}$ cents for 64x64s.

The linen trade is deeply interested in one of the largest deals which has occurred for some time in the dry goods trade—that consummated on Tuesday, when five of the Troy mills consolidated under the name of the United Shirt and Collar Company. The articles of incorporation have been filed in the office of the Secretary of State, at Albany. The capital stock of the company is $2,000,000, and the shares are distributed among the individual members of the concerns that have entered into the consolidation according to the interest they held in their late firms. The new concern is composed of the following firms: James K. P. Pine, Beiermeister & Spicer, Sanford & Robinson, Marshall & Briggs, and S. A. House's Sons. The board of directors for the first year are S. B. Sanford, James K. P. Pine, Fred Beiermeister, Jr., David C. Briggs and E. O. House. These are the gentlemen whose names appeared on the articles of incorporation. The new concern is in no way a trust or monopoly, neither will it result in a reduction of the prices of labor nor an advance in the price of shirts, collars and cuffs. The object of those who formed the company was to organize for the purpose of securing uniformity of price, and to effect a saving in the cost of placing their productions on the market. Each mill will retain its own trade-marks, the only alteration being that the different brands will all be handled from the one office in the different cities where branches will be established. At the present time the united firms are represented in New York, Boston, Chicago, Philadelphia and San Francisco. These offices will be continued and others established in the large centers throughout the country.—*Dry Goods Economist.*



The Keystone Handle.

The illustration herewith represents this handle as applied to a hammer, with the fastenings shown on a larger scale. It is intended to be used for hammers, edge tools, or other implements requiring a wooden handle, the object being to provide for the permanent and fixed attachment of the tool to the handle.

The manner of attachment of the parts will be readily understood from an inspection of the engravings.

The manufacturer of these handles is E. H. Brooks, Lebanon, Pa.

In the last month a notable attempt has been made to add to the resources of the English language. Lord Bury, as chairman of the Electric Traction Company, wrote to the *Times* to ask for a short word—if possible of one syllable—to express the idea of being conveyed by electric power. As might have been expected, letter after letter poured in, full of strange and wonderful suggestions. The following are only a few of the cacophonous verbs which scientific and unscientific writers alike submitted for consideration: to "ohm," to "volt," to "mote," to "electrize," to "coulomb," to "squirm," to "shock," to "franklin," to "scint," to "elk," to "tric-trac," to "faradate," to "weber." There is clearly no lack of choice; perhaps America will help us, as it did with the verb to "wire."—*Murray's Magazine.*

Measuring Screws—Pitch and Diameter—Varying Pitch in Taps—Uncertainties.

BY JARNO.

In addition to the diameter, it is also sometimes necessary to measure accurately the pitch of a screw thread. Some screws can be measured well enough with a scale. When threaded with a die the pitch often varies from what was expected. The variation is sometimes so great that the screws will not follow a tap that is right. In order not to throw such screws away a large tap is sometimes used, though it might be better either to throw them away or to make a tap of their varied pitch. To make a tap exact in pitch, allowance must be made for change by hardening. To determine the pitch variations caused by dies and by hardening, a special tool is a convenience. Gascon kindly showed me such a tool, of which Figs. 1 and 2, page 11, are sketches, with some changes that he suggests. He has used it for about twelve years, and it has been of great help to him in the production of accurate taps.

A is a micrometer head with a screw whose nib is pointed to an angle of sixty degrees. *B* and *C* are vernier measuring slides, which are carried upon the graduated bar *D*. On the vernier slides are the measuring nibs *N* and *O*, each consisting of a cylindrical body part and a pointed end, the body part being two-tenths of an inch diameter, and the pointed end having an angle of sixty degrees. The micrometer head *A* and the graduated bar *D* are fastened to the frame *F*, which rests upon the bed *X*, and is free to move. The centers *S* and *T* are carried in the adjustable stocks *U* and *V*, which are tongued into the slot *R* and clamped to the bed *X*.

To adjust the micrometer and the verniers, bring together the vernier nibs *N* and *O*, and place them at an equal distance from the micrometer nib *A*, as in Fig 3; place the micrometer nib so that between it and each of the vernier nibs, the perpendicular or shortest distance will be .0866″. Now adjust the micrometer so that it will read zero, and adjust the verniers so that each will read one-tenth inch from zero. The sum of the two vernier readings is now two-tenths of an inch, which is the distance apart of the two points of the vernier nibs; each of these points is one-tenth inch distant from the point of the micrometer nib *A*, .0866″, which is the perpendicular or shortest distance between a side of the micrometer nib *A*, and a side of one of the micrometer nibs is one-tenth of the cosine of thirty degrees. When the micrometer and one of the vernier slides are each at zero, their nibs will touch at the points, as in Fig. 4.

The routine of measuring a sixty-degree sharp screw thread is about as follows:

The micrometer nib *A*, Fig. 1, is placed in a thread space, and the two vernier nibs *N* and *O* are placed in any two convenient spaces, one on each side of the nib *A;* all three nibs are then set so that they will at one time touch both sides of each of the three spaces. Then the micrometer reading shows the diameter of the thread at the bottom; the sum of the vernier readings divided by the number of threads between the nibs gives the thread pitch. Thus in Fig. 1, if the micrometer reading is 5,325, then the diameter of the thread across the bottom is .5325 inch, because the zero settings are based upon having the nibs together, as in Fig. 4. If the verniers each read nine-sixteenths inch we have one inch and an eighth as the sum of the vernier readings, which divided by nine, the number of threads between the vernier nibs, as in the figure, gives one-eighth inch as the thread pitch.

Screws having both an odd and an even number of threads or leads can be measured. To measure screws having the Franklin Institute thread, the ends of the nibs should be flattened. If the points are taken off so that the flat places will be a hundredth inch diameter, the nibs can be used to measure threads ten to an inch, and finer. The nibs can be made to take out and others put in, though if any considerable number of screws and taps are to be measured it is better to have two or more measuring tools complete.

I have drawn a tapering head to the micrometer screw; Gascon wishes to caution the reader about taking hold of the small end in order to move the screw quicker, for fear that this feature may be patented.

To make a tap of such a pitch that change in hardening will bring it to standard can only be a matter of striking averages. A maker would be loath to furnish such a tap unless the customer agrees to take all those made before the right one is reached. One maker of first-class lathes is now making his own taps for the nuts of leading screws, threading them of such a pitch that the hardening will bring them to standard. If a nut has not the same pitch as the screw, it has a thread bearing only at the very ends; when put to work one thread, or a part of a thread, takes all the pressure, and by the time that all of them are strained or worn to a bearing the nut is quite loose, and in a condition to continue rapidly to wear out.

From a city fifty miles away Gascon received a letter written by a man who was in high dudgeon because some machine screws would not follow a tap. The man was sure that this tap was wrong because the same screws would follow another tap made by one of Gascon's competitors called Mephit. As the man had been a large buyer of taps, and Gascon being anxious to learn wherein those of Mephit were better, he made a tour of investigation, though he felt that the man had made some mistake. A tap maker has frequent occasion to be an educator, and he sometimes submits to loss, more from motives of policy than from a sense of justice. He would as soon think that he had sent out a tap that is not fluted as one that is not large enough. Whatever variation he allows from the exact diameter should be to have it larger, and, except by special order, never any smaller than the standard size. The screws did not follow Gascon's tap clear through a test piece that was about half an inch thick, but they did follow in three-eighths inch. In this piece there were two holes more—one threaded by Mephit's tap, which the screws followed clear through, the other by Mudquill's tap, which the screws followed only an eighth inch. Gascon suggested that the test piece be planed down to three-eighths inch thick just around the hole threaded by his tap, which being done, the screws went clear through. The man did not understand this. Gascon said:

"Now if you had happened to have planed your test piece three-eighths thick, Mephit's tap would have been too large, and he, instead of myself, would have been the one to get the fault-finding letter. If it had been an eighth inch thick Mudquill's tap would have been right, mine large, and Mephit's still larger. Having threaded a hole with a tap that is too small, we can, without even touching it, make the same tap just right, and then too large. How wonderful it is that you can change the size of a tap by merely changing the thickness of your test tool!"

The trouble lay with the screws, and is one that machinists well know; having been threaded with a die that did its own leading, their pitch was not standard. They were also small in diameter. As they could bear only upon two threads in a hole having any pitch other than their own, it was Gascon's aim to plane down the test piece until these two threads were reached. Holes for machine screws are sometimes counterbored so as to make the threaded part short enough to have the screws follow. I asked Mr. McGregor whether he ever had any trouble with the pitch of die-threaded screws because it was not like that of the tap; he said: "Have I ever had anything but trouble?" Mr. Norton has made screw test tools as thick as the screw holes are deep; then, if a screw fits the test tool it is sure to go. A workman had tried the largest tap, and still the screws would not go deep enough. With a lead hammer, and almost in anger, he struck one of them endwise, and then found it would go, because the blow had strained the threads that bore hardest into a position where they did not bear so hard.

To cut a long screw with a thin die is like measuring a hundred feet with a thin scale. As a die gets dull the screw is likely to be stretched, and the pitch made coarse. A die will stretch soft stock more than hard. Screws should be tested for pitch as well as the diameter of thread. There is a reason for getting all the wear out of a die, still, after it begins to thread too much away from the standard pitch, a farther use of the die causes much trouble to the user of the screws. To size screws to a thin gauge without regard to their pitch gives us but little surety that they are right. Just now a workman hast lost considerable time, and has got himself into a sweat, by repeated trials to get the holes large enough with a piece of waste around his tap. He would have saved time if he had begun by threading his screws in a lathe.

Gascon says that before long we shall have lathes in which a tap can be put on the centers as a test, and an adjustment made corresponding to the change of the tap in hardening, so as to cut a screw that will accurately follow. For the purpose of making slight changes in the lead of a lathe, a device having a slide running on a bar that can be set to an incline was published nearly fifty years ago, by Holtzapffel. A similar principle is used in rifling machines. We should expect to use this device for feed screws and others subjected to heavy pressures, and not for leading screws.

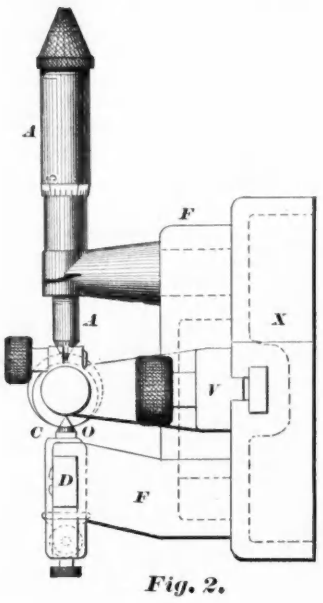


Fig. 2.

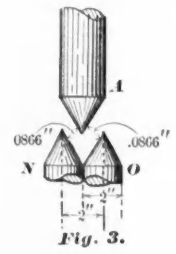
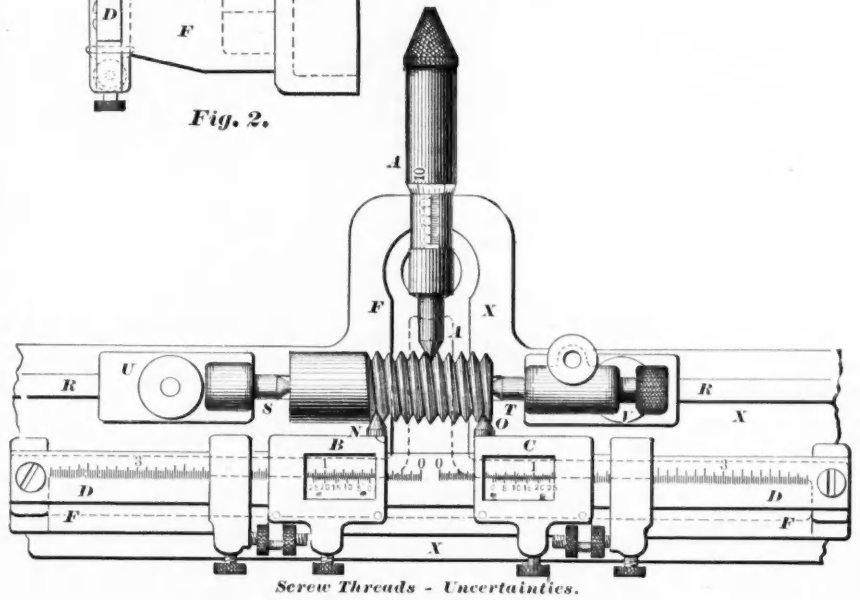


Fig. 3.

Fig. 4.

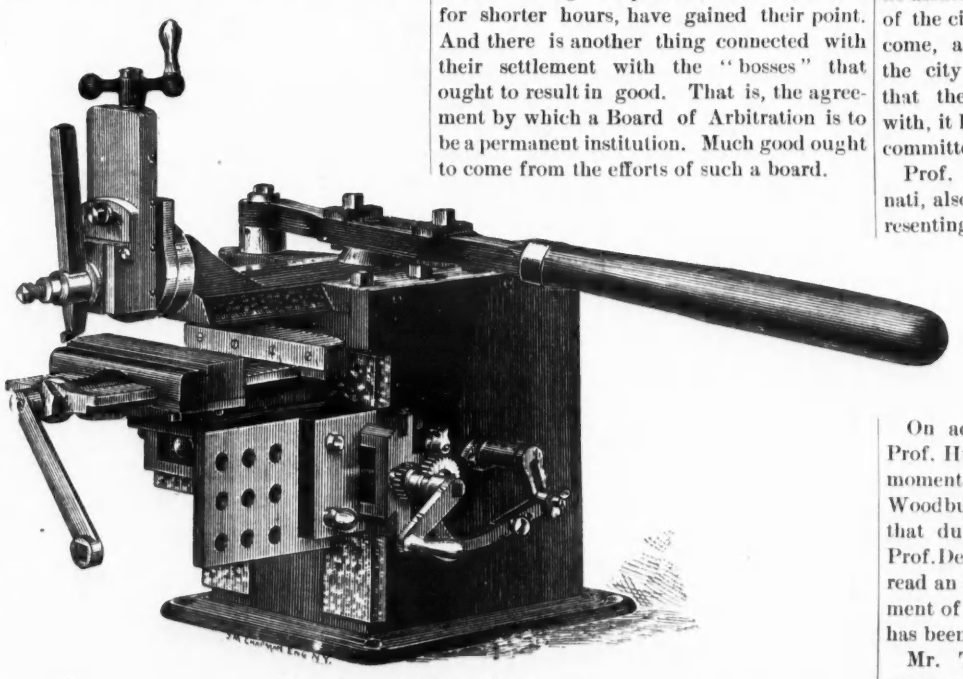


Screw Threads - Uncertainties.

Fig. 1.

MEASURING SCREWS—SEE PAGE 10.

The Chicago carpenters, who contended for shorter hours, have gained their point. And there is another thing connected with their settlement with the "bosses" that ought to result in good. That is, the agreement by which a Board of Arbitration is to be a permanent institution. Much good ought to come from the efforts of such a board.



HANGOTZKY'S HAND SHAPER.

The following, if coming from a Senate Committee, for instance, would sound strange to the people of this country. We take it from an Associated Press dispatch:

"The committee of the House of Lords, appointed to inquire into the 'sweating' system, which is causing much of the misery among the residents of the eastern part of the city, urges the hands to combine, and by organization force their employers to pay better wages and grant shorter hours of labor."

Hangotzky's Hand Shaper.

The accompanying illustration represents a hand shaper designed for a comparatively large range of work, and it is adapted to the work of experimenters, amateurs, etc. The machine is worked by a lever 25 inches in length; the slot in the lever provides means for changing the stroke of the ram within the range of 10 inches. The chuck swivels to any desired angle, and can be set to a scale marked off on the head of the ram, the scale ranging from 0 to 90 degrees either way. The knee supports a table to which the work is clamped; the knee is also placed on the side and arranged for the reception of work. The table is moved along either way with an automatic feed actuated from the ram.

As will be seen, the machine is very compact; its weight is about 70 pounds; and on the bench it takes up about as much room as an ordinary vise. With a depth of cut of about $\frac{3}{64}$ of an inch, and an exertion of 12 pounds pressure on the end of the lever, about 60 square inches of surface can be gone over and removed with the aid of this machine in 25 to 30 minutes.

The inventor is Mr. Hangotzky, 168 Academy street, Newark, N. J.

The Cincinnati Meeting of the American Society of Mechanical Engineers.

The twenty-first meeting of the American Society of Mechanical Engineers was convened at the Scottish Rite Cathedral on Tuesday evening, May 13th, at 8 o'clock, Mr. Geo. A. Gray, chairman of the local committee, calling the meeting to order, and introducing Mr. M. E. Ingalls, president C. C. C. & St. L. R'y, who cordially welcomed the society to Cincinnati, and said that what would seem the most appropriate action would be to thank the society for having chosen the city for its place of meeting. In looking over the catalogue of the society he had been greatly surprised at the array of great names included in its membership, and called attention to the great advantage it would have been to the world if such a society had been formed in 1780 instead of 1880, and had kept its records as carefully as they were now being kept. The history of the development of the country could then have been read from the record of its transactions. After mentioning the advantages of the city as a manufacturing point, he assured the members that all the citizens of the city would join in a most hearty welcome, and that if there was anything in the city which the engineers wanted and that the committee did not supply them with, it had only to be mentioned, and a new committee would be immediately appointed.

Prof. Eddy, of the University of Cincinnati, also made an address of welcome, representing especially the educational interests of the city. President Smith, in replying, paid a high compliment to the engineering development of the city, and expressed confidence that the meeting, which for the first time was held there, would be of interest and profit.

On account of sickness in the family of Prof. Hutton, he was prevented, at the last moment, from attending, and Mr. C. J. H. Woodbury acted as secretary, performing that duty in a very satisfactory manner. Prof. Denton not being present, the secretary read an abstract of his paper on the Measurement of the Durabiilty of Lubricants, which has been published in our columns.

Mr. T. R. Almond, in discussing the paper, mentioned a case which had come within his experience, in which a bearing had run for about twelve months supplied with one and a half points of oil, which, when it had been reduced to one pint, was replenished by the addition of one-half pint, the result being that the bearing at once began to heat, and continued to do so for several weeks, after which it again cooled down to its normal temperature, showing, he thought, that oil might, under certain circumstances, be improved by use.

Several members discussed the matter, referring to experience with the Westinghouse engine, the crank of which runs in oil, also to the fact that engines have been run without cylinder lubrication after a good surface was secured, Mr. Strong recommending for this a mixture of beeswax and plumbago.

Prof. Webb thought the results obtained by Mr. Almond might be due to the fact that evaporation of oil took place in use, and that the oil happened to be of such character as to be improved by that evaporation for the service it was being used for.

Mr. C. S. Dutton read a paper on Some Experiences with Chain Cranes, having with him some specimens of broken links of such chains. The paper was discussed at length by Mr. Henning, who agreed substantially with the position taken by the author, the most important conclusion being that crystallization did not take place under anything like fair treatment, but that the failure of such chains was to be attributed almost entirely to poor material, or material not adapted to the purpose.

The reading of Mr. Barrus' paper on Memoranda on Indicating Engines of the steamer "City of Richmond" completed the session.

Wednesday morning's session opened with the reports of the tellers of election and of the council. The total membership now reaches 1,133. The report of council gave the particulars as to the purchase by the society of the new building on 31st street, New York, which has been already referred to. The cost is $60,000 and the response of the members to the request for funds with which to make a sufficient payment to secure the transfer of the property had been very satisfactory, over $10,000 more than was necessary for this purpose having been promptly subscribed. The secretary also read a report from a committee appointed to memorialize Congress on the subject of taking some suitable action in recognition of the services of John Ericsson. The report was in the form of an address to the Senate and House of Representatives, and after reviewing at length the important services of Ericsson to the country, calls attention to the fact that this his adopted country is the only one almost among civilized countries that has failed to take some appropriate action in his honor. They therefore ask that this be done by Congress, not specifying the method or form.

Reports of committees on Duty Trials of Pumping Engines and on Uniform Methods of Tests were received and accepted by vote of the society. Mr. Henning on behalf of the latter committee stated that its work was not yet completed, especially that part of it which related to shop or routine tests, which they hoped to be able to present a standard method for, which would be uniform, and so make all such tests comparable with one another in all countries. The committee had already done much, as was shown by its report, but there yet remains much to do. On motion the committee was continued. A motion was carried to appoint a committee of seven members to examine and report on the comparative economy of simple and compound locomotives, the motion bringing on a discussion which showed that much interest was taken in the subject. After this the rest of the session was taken up by presentation of professional papers, and as the rain continued to pour down, the carriage ride which had been arranged for the afternoon was postponed, and the entire day and evening devoted to the reading of papers and to topical discussions, some account of which will be given next week together with the account of the excursion to Hamilton on Thursday, and the reception by the citizens of Cincinnati in the evening.

The attendance at the meeting was very good, and much interest was manifested in the reading of the papers and in the discussions.

A curious as well as distressing elevator accident occurred in this city recently. The elevator was to be repaired, and three men were working at it. They had the cage down at the bottom, and proceeded to disconnect the cable from it without disconnecting or arranging any support for the counterweight. Two of them had hold of the cable when it was got loose from the cage, and they hung on to it while the heavy counterweight pulled them up toward the top of the building. One of them let go when he reached the second story, and, falling to the bottom, broke both his ankles, and otherwise seriously injured him. The other man hung on until he reached the top, where, of course, his hold was broken, and he fell the whole distance, dying in a few moments.

The papers contain the news that the Attorney General of Ohio has brought suit against the Standard Oil Company to deprive it of its charter, the ground upon which the suit is brought being that the company has forfeited its right by going into a trust company, and receiving its certificates of stock instead of its own shares, none of the trustees of the Trust Company residing in the State. This suit will probably prove quite annoying to the Standard, and may cost it considerable money to settle; but that it will result in seriously crippling or interfering with its operations few will believe. The Standard Oil Company has shown upon several occasions that it owns a pretty good share of Ohio.

The Old Colony Railroad Company has determined to test the constitutionality of the Massachusetts law that provides for workmen receiving their pay once a week. The road has been indicted, and will undoubtedly take the case to the higher courts.

There is soon to be taken a census of the United States. In taking this census it is proposed that the inhabitants shall answer—under heavy penalty for refusal—some of the most extravagantly foolish questions ever before conceived. If the taking of the census is carried out in the letter of the law, it will be one of the most inquisitorial schemes ever devised in this country. But there are a good many questions to be propounded that sensible men will not answer, and that will be the end of it. There are questions in the schedule that a Russian would take a trip to Siberia before he would reply to.

Kaiser Wilhelm, of Germany, in his recent speech at the opening of the Reichstag, spoke strongly in favor of "protection of the workingmen." Better let the workingmen protect themselves. They will do this if treated as other citizens are treated. But the simple fact is that the workingman has to provide, by his labor, for all the expenses of government, and in Germany one item of this is the support of an immense army—a tremendous contingent—of idlers. Just how his condition is to be materially remedied the kaiser does not explain. In time, we have no doubt, it will be explained to the kaiser.

The great fire at Elizabethport may deprive some hundreds—possibly thousands—of people of a chance to earn their living for months to come. That is the worst feature of the case. The loss of the Singer Company, although very large, is said to be covered by insurance.—*Mail and Express.*

Quite true; but this loss to the insurance companies must, in the end, be made good by people who "want a chance to earn their living." It is a loss to men who work.

Machinists' Supplies and Iron.

NEW YORK, May 17, 1890.

Iron—American Pig.—The demand is no better than one week ago. Few large orders are being placed, the stock being left in first hands. There has been a feeling that holders would give way a little in price, but if they are doing so it is only to a small extent, and very quietly. There are good reasons for believing that prices will be held at about present figures until some unforeseen change takes place, but rather excessive production leads consumers to hope for easier prices.

We quote, for Northern brands, Choice, $18 to $19 for No. 1 Foundry; No. 2, $17 to $17.50. Southern brands can be had for $16.50 to $17 for No. 1 Foundry, and $16 to $16.25 for No 2.

Scotch Pig—There is very little doing in Scotch brands. Quotations are: Eglinton, $19; Dalmellington, $21.50; Coltness, $25. At these prices there will be little Scotch Pig sold here.

Bessemer Pig—Prices have ruled $17 to $17.50.

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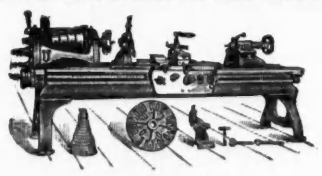

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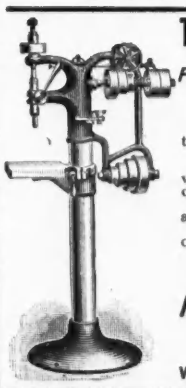

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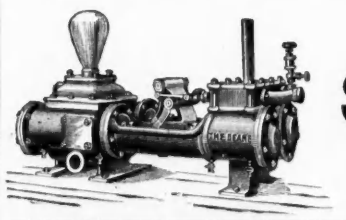

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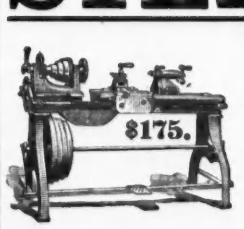

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Lead—Comparatively small lots are offered. Dealers are holding for 4.15c , while consumers bid 4.10c.

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Spelter—There is a fairly good demand, but not enough to stiffen prices materially. Western is held at 5.10c. to 5.15c. for Ordinary, 5.20c. to 5.25c. for Prime, and 5.45c. for Extra Choice.

Tin—The market is firm, with an evident intention to maintain recent advances. Jobbing lots have sold at 21¼c. to 21⅜c.

Antimony—Hallett's, 19¼c. to 19½c.; Cookson's, 25c. to 26c.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 90 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Draftsman who is exp'd with arc electric apparatus. Address S. N. R., AM. MACHINIST.

Wanted—Good general machinist to work on Corliss engines, ice and refrigerating machinery. Address Frick Company, Waynesboro. Franklin Co., Pa.

Malleable iron foreman is open for engagement; understands mixing and melting. General jobbing shop preferred. X, AMERICAN MACHINIST.

Wanted—Situation as foreman by practical machinist thoroughly experienced on engine and gen'l machine work. Address "D," AM. MACHINIST.

Wanted—For three months, a mechanical draftsman. Apply at once to the Clapp & Jones Mfg. Co., Hudson, N. Y.

Wanted—Capable foreman for job iron foundry in Conn. State experience, and salary expected. Address Mach'y Castings, AMERICAN MACHINIST.

Wanted—A first-class pattern maker. Steady work and good pay to the right man. Address Box 16, AMERICAN MACHINIST.

Wanted—First-class machinists. Steady work, good pay, to right men. Address, stating work accustomed to, habits, etc., Box 19, AM. MACHINIST.

Wanted—A first-class shafting turner to work on a regular shafting lathe. Steady employment in St. Louis, Mo. Address Box 18, AMERICAN MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Machinists Wanted—First-class vise and lathe hands on punching machinery and machine tools; also pattern maker. Steady job and good pay. W. Frech Machine Works, Streator, Ill.

A mechanical engineer who has been sup't of large works for years wants position. Engines, boilers, sugar and general machinery. New York City. References. Box 20, AMERICAN MACHINIST.

Wanted—Competent mech. draftsman, familiar with saw and shingle-mill mach'y. State age, exp., married or single; enclose photo; give refs., wages wanted. Steady employment. D. R. Co., AM. MACH.

Wanted—Foreman for machine shop in large city in Wis., employing about 100 men. One posted on Corliss engines and ice machines, and who understands German, preferred. S. A., AM. MACHINIST.

Tool maker and machinist, with long experience on all kinds of work, wants a position where skill, experience and ability to handle men are required. References. Address "Machinist," P. O. Box, 1592, Philadelphia, Pa.

Wanted—A foreman boiler maker for a first-class establishment on the Pacific coast. He must thoroughly understand marine and stationary boilers; also repairing. Apply, by letter only, to Boilers, AMERICAN MACHINIST.

A practical foundry foreman desires a position as such. Had 20 years' experience in every grade of foundry castings; is perfectly sober and reliable man; will give the best of references. Address R. L. N., 151 Oakland st., Brooklyn, E. D.

Wanted—10 or 12 good machinists, principally vise hands. Only those familiar with the erecting of wood-working machinery need apply. This will be a good opening for ambitious young men. Address E. & B. Holmes, 59 Chicago st., Buffalo, N. Y.

Machinist of 25 years' experience, having filled position of foreman, master mechanic, desires position taking charge of shop. Has been used to marine engine work, cotton compress, rolling mill work, sugar machinery, etc. Address G. P., Box 1592, Philadelphia, Pa.

A Shop Foreman—A foundry and machine shop employing about 200 men, located within 50 miles of Boston, is in need of a machine shop foreman who knows how to obtain first-class work from men and tools in the fewest possible hours. A man with some experience in printing presses preferred. Address "Webster," care AMERICAN MACHINIST.

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Advertisements will be inserted under this head at 35 cents per line, each insertion.

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Castings of every description and machinery built. Address Cedar Point Foundry, Port Henry, N. Y.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

For Sale—Patent right of Calipers. Address E. V. Faucett, 14 E. 7th St., Wilmington, Del.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Simonsen-Walter Mfg. Co., Jefferson City, Mo., with modern foundry, machine and wood-work plant, wants spec. to manuf. for Western trade.

Wanted—A good second-hand planer, 7 or 8 feet square by 12 or 14 feet long. Address Box 17, AMERICAN MACHINIST.

Wanted—A large boring bar, 12 ft. long, with sliding and facing heads; the latter to reach 4 ft. in diameter. Rand Drill Co., North Tarrytown, N. Y.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

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For Sale—The patent on a hand-shaper, especially adapted for tool makers, experimental work or small machine work. Description of shaper with wood cut, on application to John F. Seidel, 176 William st., Newark, N. J.

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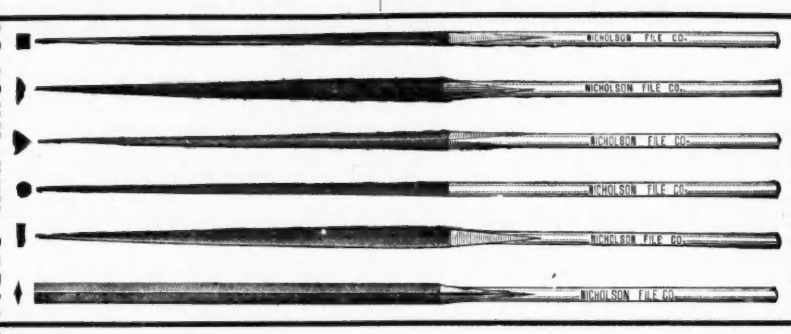

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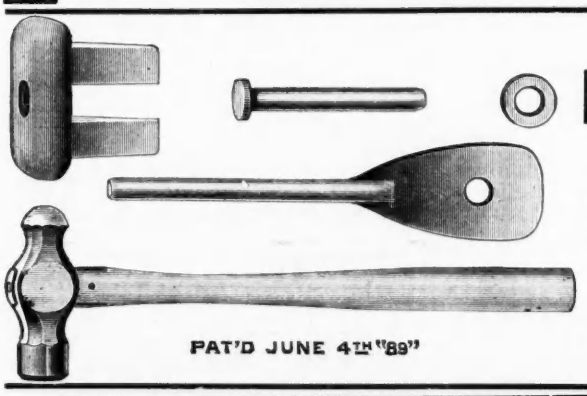

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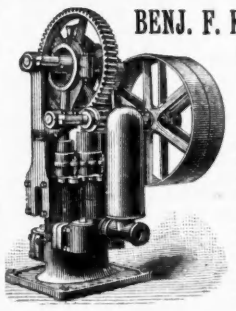

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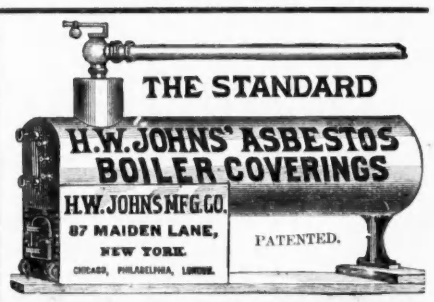

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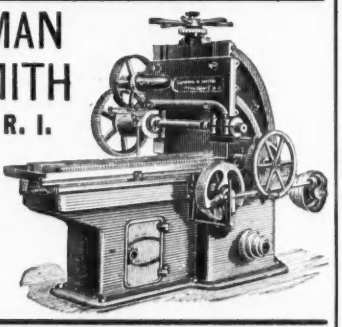

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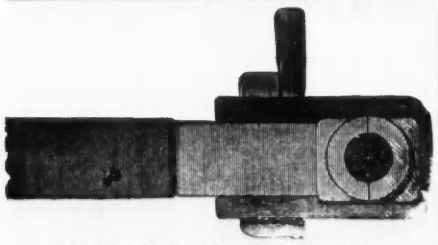

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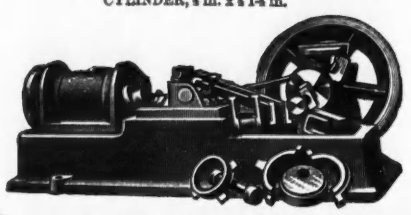

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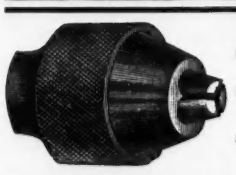

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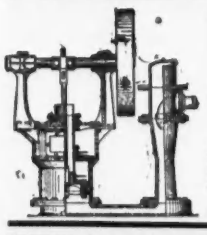

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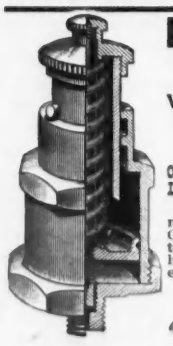

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The following list is published to facilitate the ordering of back numbers containing them. Any of these issues can be ordered through any newsdealer, or of the publishers direct, at the price then ruling, viz: 5 Cents a Copy.

1886.

Pattern Making. Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast-iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec. 18.
Foundry Practice, Articles on. By S. Bolland, May 8, 22 29, June 26, July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H. Babcock and C. A. Smith, July 3, 24, Aug. 7, 14, 21, Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30.
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives, Oct. 30.
Casting Face-plates Face Up. By David Spence, Oct. 23.
A Job of Shaft Straightening. By F. L. Johnson, Oct. 23.
Inventory Valuation of Machinery Plant. By Oberlin Smith, Aug. 7.
Making a Cast-iron Sheave. By P. S. Dingey, July 31.
New Dredge Boiler designed by Norman Wheeler, July 17.
Core Oven with Rotating Back. By Thos. Wathey, July 24.
Universal Table for Lathe Change Gears for Screw Cutting. By Joshua Rose, July 24.
Gating, Clamping and Securing Chaplets By Matthew Wiard, May 1.
Printing Frame and Manner of Making Blue Prints. By C. L. Redfield, July 31.
Some Pressure Tests. By C. O Sine, Nov. 27.
An Expanding Mandrel—Turning Tapers. By Chas. S. Beach, Nov. 27.
Core Making in Foundries. By David Spence, Nov. 20.
Making Pattern for Spiral Grooved Drum. By Geo. Allge, Aug. 14.
Rolling Conic Sections Applied to Gears. By Geo. B. Grant, Nov. 6.
Ninety-inch Belpaire Fire-box Boiler, Nov. 6.
Spacing in the Milling Machine. By Chas. S. Beach, Aug. 21.
Engine Crossheads. By J. G. Tramis, Aug 21
Traction and Adhesion. By A. B. Ropes, Aug. 28.
Internal Key-seating on Milling Machines. By A B Landis, April 17.
Tapping Holes in Boilers. By A. B. Landis, April 24.
How to True Emery Wheels. By L. Best, April 24.
Work and System in the Drawing-room. By C L Redfield, Aug. 28.
Oiling Lathe Carriage Ways. By Wm. H. Bradt, Aug. 28.
Moulding a Screw or Worm without Cores. By George Allge. Sept 11, 18.
Power Absorbed in Cutting Cast-iron. By James F Hobart. Sept. 11, 18.
Moulding Screw Propellers in Loam. By Chas. A. Devlin, Sept. 18.
Dimensions of Wrought iron Pipes in England. By A. G. Brown, Sept 4.
Truing Up and Replacing Milling Machine Centers with Accurate Alignment. By A. B. Landis Jan. 16.
Methods of Working and Tempering Steel By S. W. Goodyear, Jan. 9.
Slotting Tool. By J. J. Bingley, May 8.
How to Make Clean Solid Castings at Least Possible Cost. By Matthew Wiard, April 10
Truing Milling Machine Centers. By W. R. Ballou April 10.
Lining Engine Lathes. By Chas. S. Beach, April 10.
Steam Piping. By J. G. Tramis, April 10.
An Equalizing Dog. By A. B. Landis, April 10.
Screw Cutting Dies. By John J. Grant, April 10.
Some Handy Shop Tools. By Fred. H. Colvin April 3.
Moulding Bells for Blast Furnaces in Green Sand Without Patterns. By Geo. O Vair, April 3
Furnace for Heating Long Bars. By W. G. Richards, April 3.
Cutting Tools—Roll Turning. By S. W. Goodyear Oct. 16.
Hydraulic Forging. By J. Richards, July 10.
A "Box" Jig. By C. E. Simonds, June 19.
Cheap Testing Machine. By Wm. Merrill, Feb. 6.
Boring Deep Holes. By A. B. Landis, Mar 27 May 8.
Working Steel and Iron. By S. W. Goodyear Feb. 13.
Inventory Valuations of Patterns. By W. E. Matheson and others, Jan. 9, Feb. 13, 20, Mar. 6
Making Cast-iron Half Boxes. By A. J. Shaw Feb. 6.
Draining Steam Pipes. By W. E. Crane, Feb. 6.
Brazing and Welding Iron. By J. F. Hobart Mar. 6.
Deep Holes by Continuous Boring. By A. B. Landis, Mar. 27.
Slotting Machine Tool. By Wm. Foster, Mar. 20.
Compound Engines for Stationary or Factory Purposes. By W. H Hoffman, April 24, May 1, 22.
Engineering Subjects, Articles on. By W. H. Hoffman, Mar. 13, July 24, 31, Aug. 21, Oct. 9.
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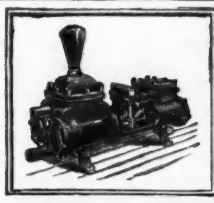

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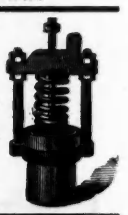

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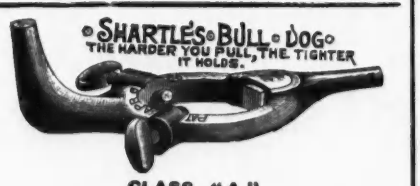

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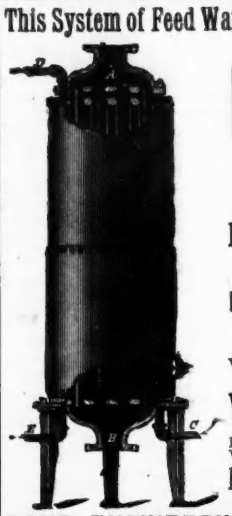

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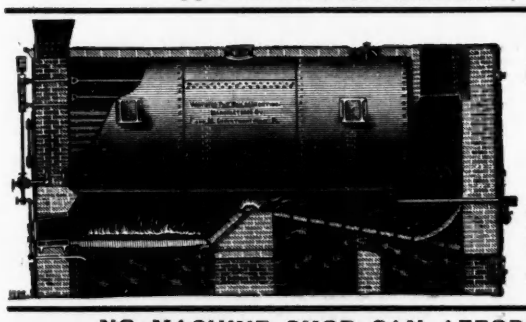

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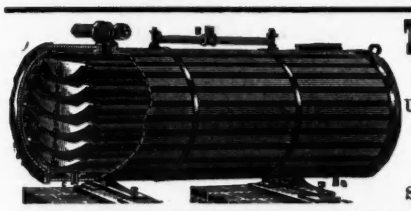

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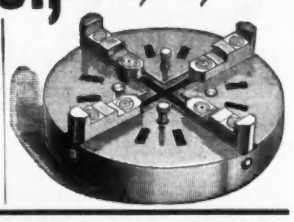

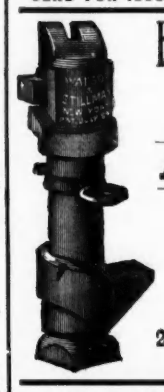

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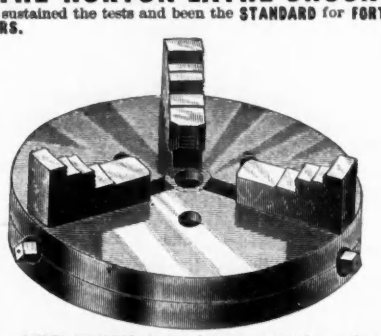

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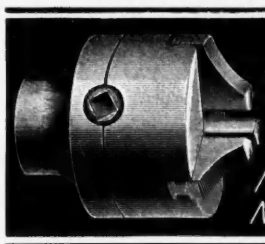
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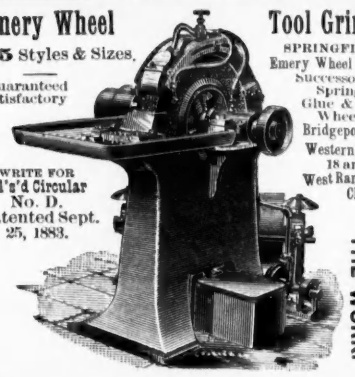

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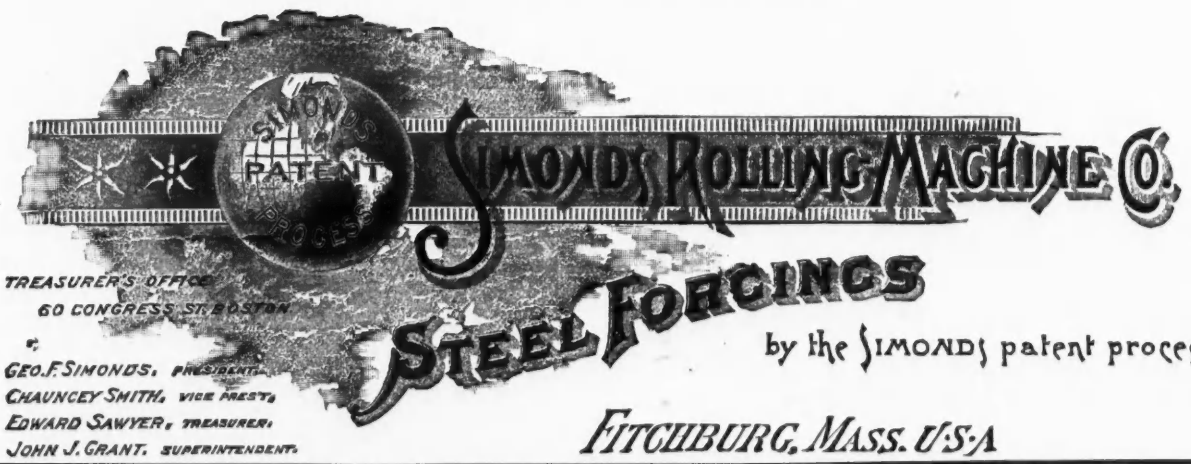

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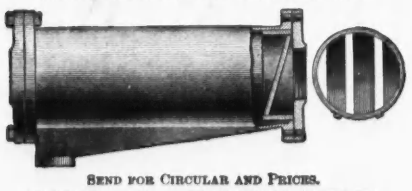

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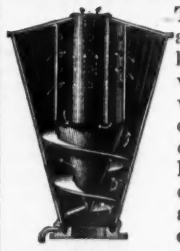

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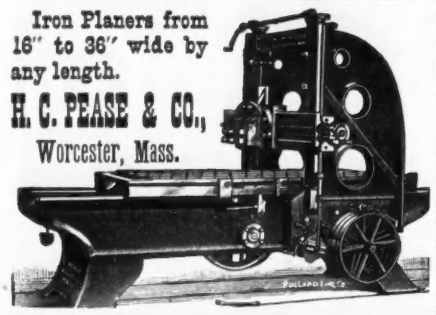

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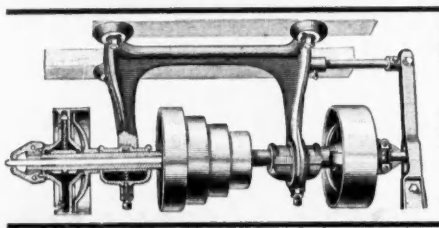

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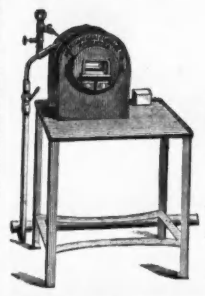

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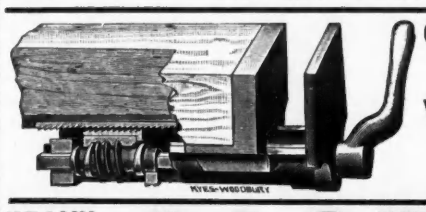

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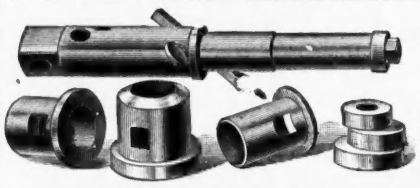

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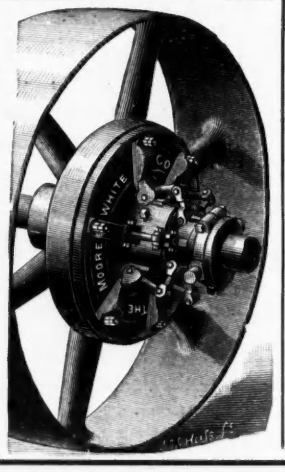

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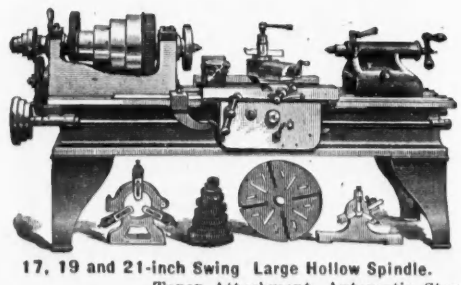
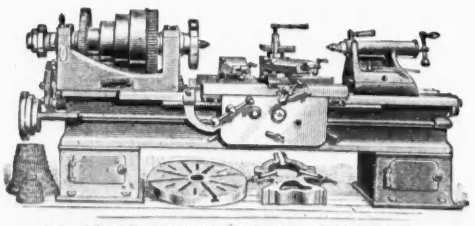
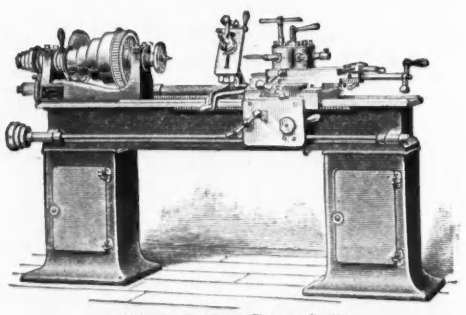


17, 19 and 21-inch Swing Large Hollow Spindle.



24, 27, 32 and 38-inch Swing, Cabinet Legs.
Taper Attachment, Automatic Stop, Compound Rest, Lead Screw under front V. All feeds reversed in apron. Extra heavy, Convenient, and easily handled.



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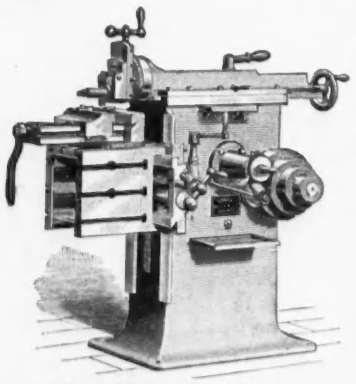

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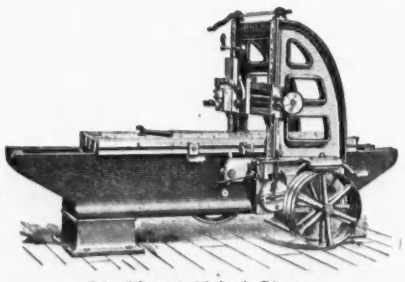

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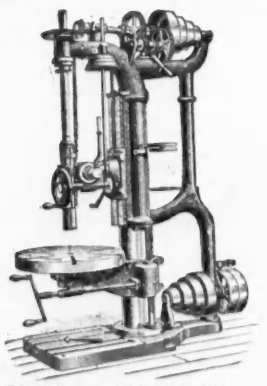

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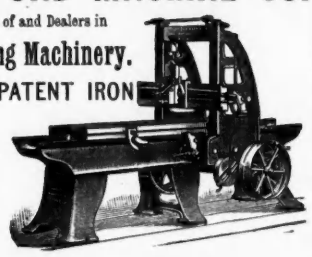

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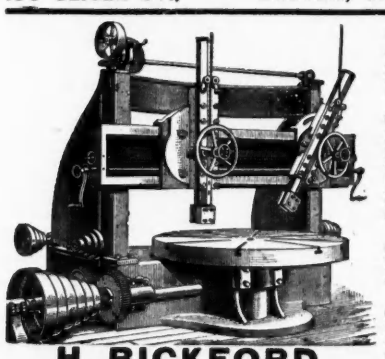

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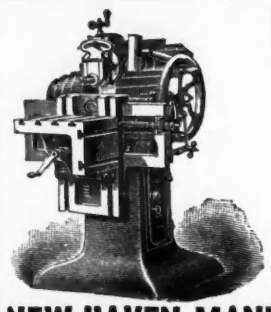

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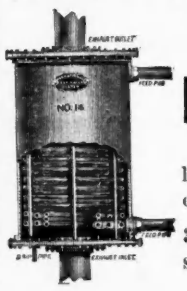

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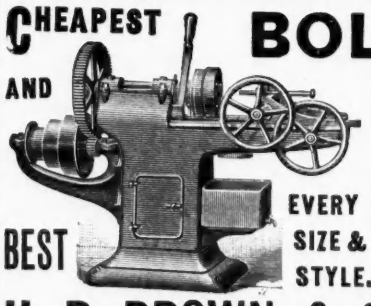

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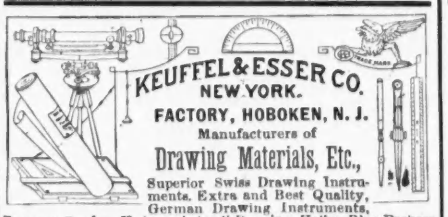

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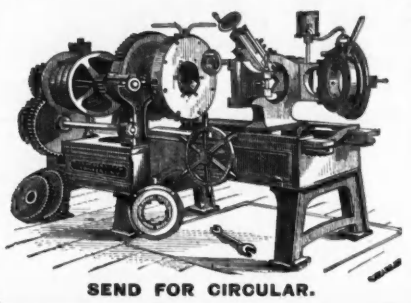

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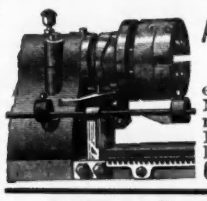

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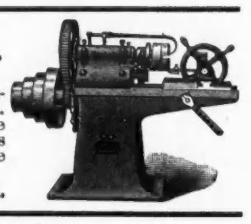

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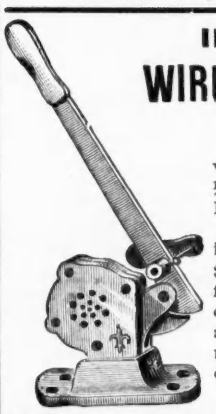

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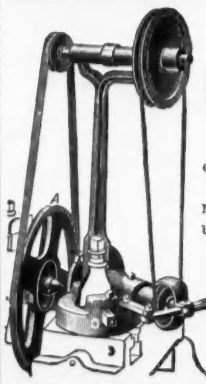

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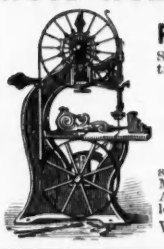

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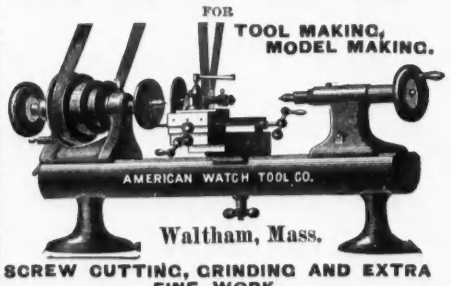

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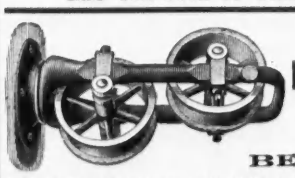

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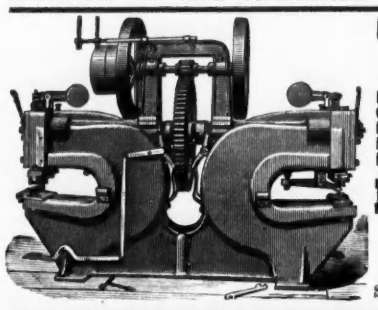

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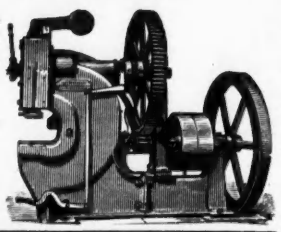

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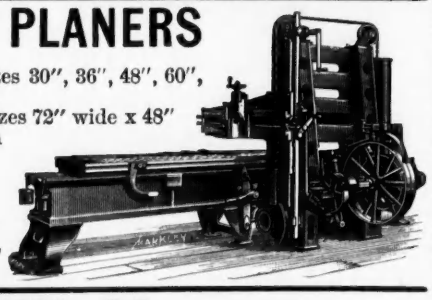

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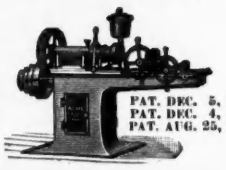

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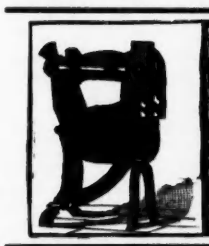
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.



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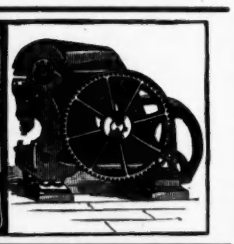

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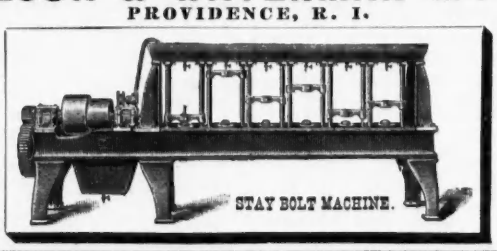

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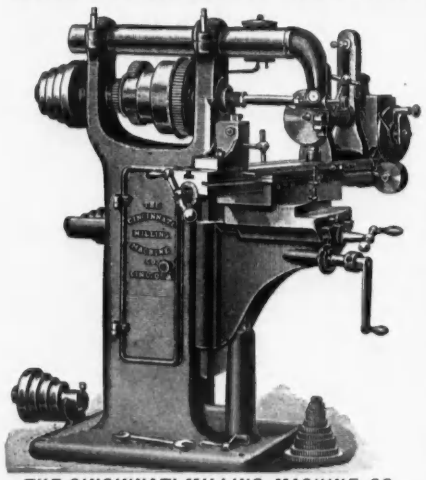

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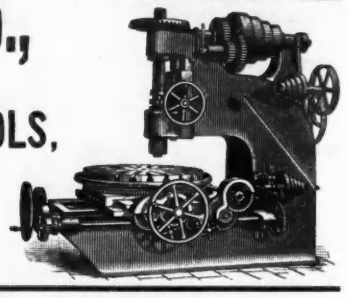

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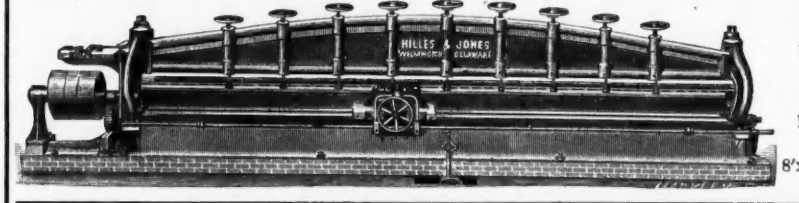

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☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.

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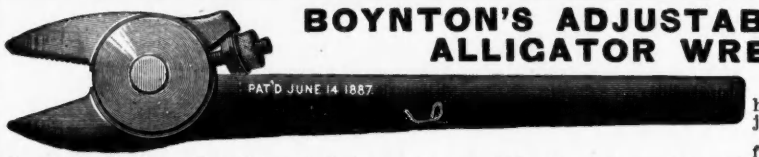

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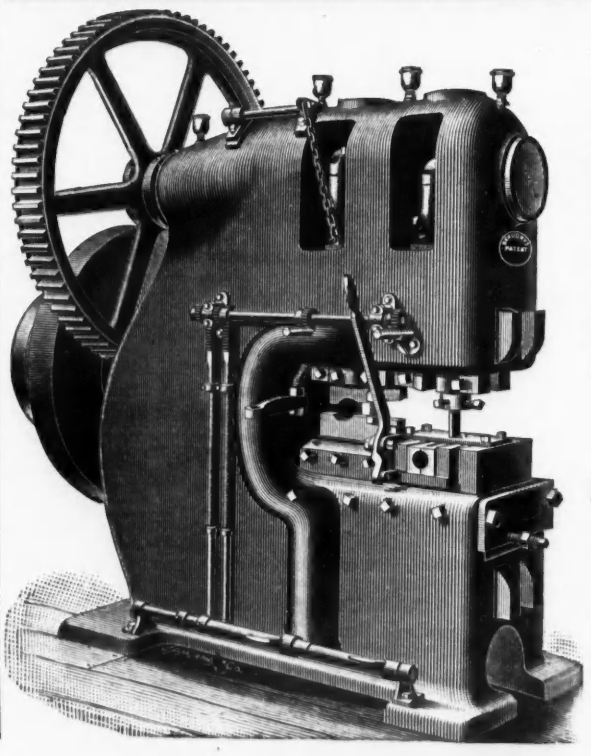

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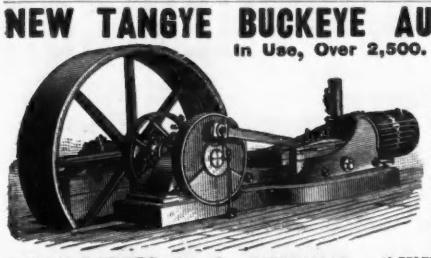
25 to 1,000 H. P.



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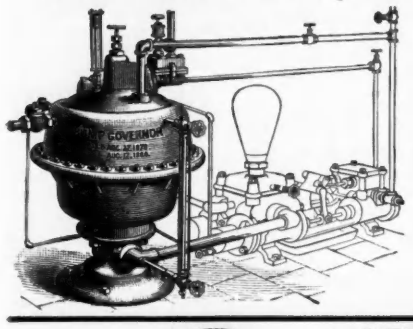

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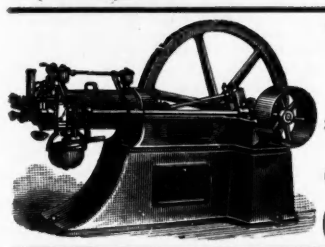

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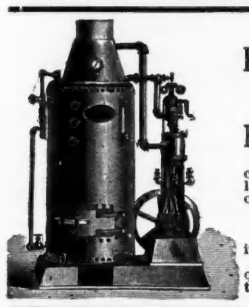

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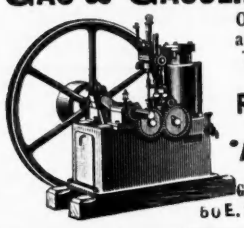

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" "	20 in.x 10-14 ft.	Wright,	"
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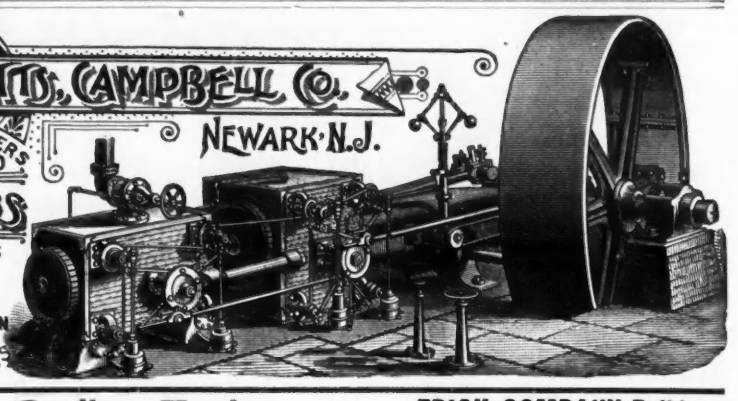

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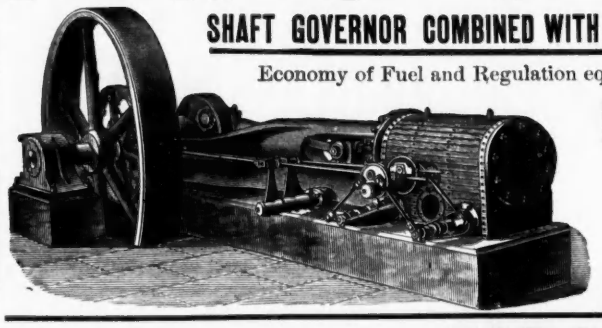

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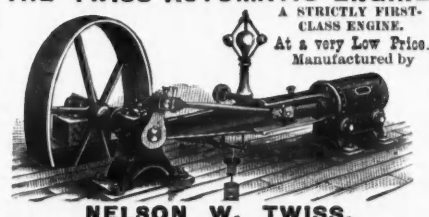

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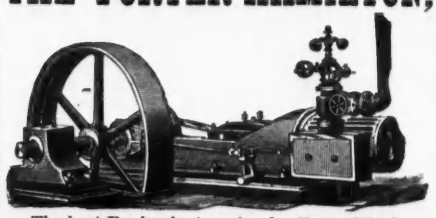

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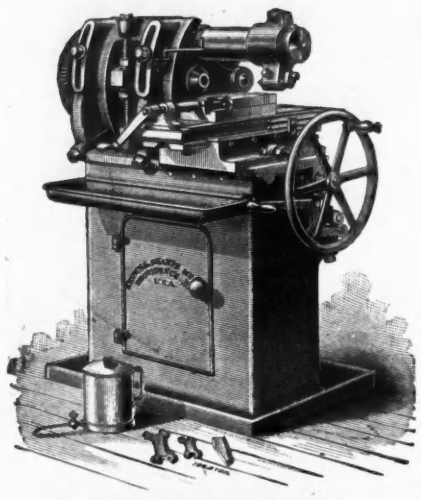

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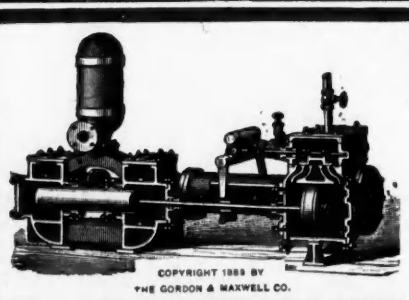

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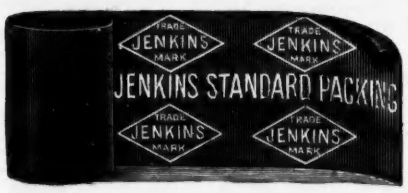

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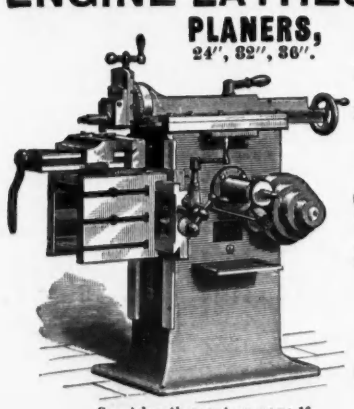

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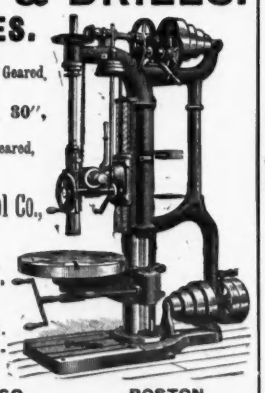

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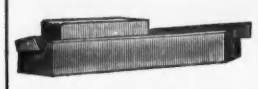

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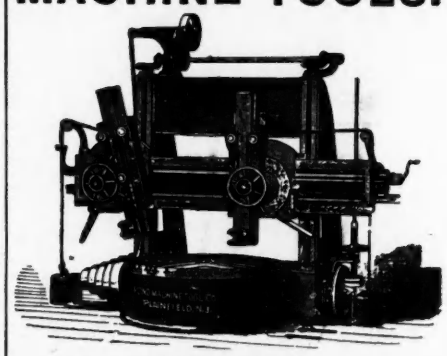

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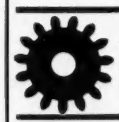

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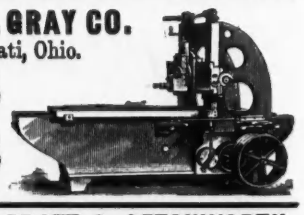

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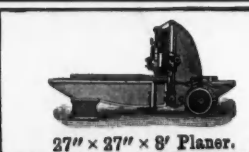

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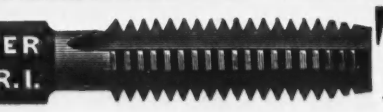

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